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**WASTEWATER TREATMENT PLANT ENVIRONMENTAL STUDY  
SHAW AIR FORCE BASE, SOUTH CAROLINA**

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## **PREFACE**

This report is a record of actions taken at Shaw Air Force Base, South Carolina, under the Wastewater Treatment Plant Environmental Study Program for the purpose of improving the performance of the wastewater treatment plant (WWTP) serving the installation.

During Phase I of the project, an on-site evaluation was made at Shaw AFB by a team composed of personnel from Engineering-Science, Inc. (ES).

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## **EXECUTIVE SUMMARY**

The Wastewater Treatment Plant Environmental Study Program is a major program designed to correct operational and maintenance shortcomings at U.S. Air Force base wastewater treatment plants. This is a three-phase program, as outlined below:

- Phase I - On-site diagnostic evaluation of a WWTP to identify shortcomings and determine what assistance is needed to correct them.
- Phase II - Preparation of a plant-specific Operation and Maintenance Manual and on-site implementation and support for improving O&M, sampling and lab testing.
- Phase III - On-site verification and benefit analysis to assess the effectiveness of assistance provided during Phase I and Phase II.

The Phase I site visit was conducted in April 1994. At the time of the visit, the Shaw AFB WWTP was generally a well operated facility. The plant process operation did have some problems and it was the consensus of the evaluation team that the strategy for operating the activated sludge system should be changed. Furthermore, there were several other unit process operations that need to be established or amended to ensure their effectiveness. Discharge data indicates that the WWTP has had thirty instances of exceeding NPDES permit limitations during the twelve months preceding the Phase I evaluation. These exceedences were for monthly average permit limitations and monthly maximums for flow, biochemical oxygen demand, total suspended solids, total chlorine residual and fecal coliform bacteria. The plant had just undergone an upgrade which was completed in March 1994. Some of the exceedences were after the plant upgrade. The major problem with the activated sludge system process operation is related to the lack of a clear cut, consistent process control strategy. Key recommendations of the Phase I Report include implementing a plant process control strategy based on maintaining a constant sludge retention time, establishment of a small process control laboratory for the operations staff, installing a waste sludge flow meter, making improvements in the influent pH control system, establishing new procedures for operating the aerobic digesters, prioritizing the maintenance of the truck used for hauling liquid sludge to the

land application site, troubleshooting and making necessary modifications to the grit removal system, making modifications in the piping surrounding the effluent filters and the new chlorine contact chamber so that full utilization can be gained from the new process and replacing the media in the effluent filters. A total of 37 recommendations were made as a result of the Phase I visit.

The format of the Phase I report generally follows that provided in *A Guide to the Department of Defense Operation, Maintenance and Training Assistance Program (OMTAP) for Wastewater Treatment Plant Personnel*, June 1987. In addition, reference to particular points in the scope of work are included after pertinent discussions throughout the report.

The initial Phase II visit to Shaw AFB is scheduled for July 11, 1994.

## **SECTION 1**

### **INTRODUCTION**

#### **1.1 DESCRIPTION OF WASTEWATER TREATMENT PLANT ENVIRONMENTAL STUDY**

The wastewater treatment plant environmental study is an outgrowth of the OMTAP (Operation, Maintenance and Training Assistance Program), a Department of Defense program designed to improve the performance of wastewater treatment plants located on military installations. The program is divided into three phases, each requiring visits to the treatment facility by a team of evaluators.

As the program is currently designed, the first phase involves a comprehensive diagnostic evaluation of the treatment processes to identify operational and/or design deficiencies. During this site visit, the evaluation team members conduct a comprehensive process evaluation and collect information needed to produce a draft of an operation and maintenance (O&M) manual for the plant. Reviews of operations, maintenance, and laboratory procedures are conducted. Evaluation of plant records and permit compliance are also conducted.

The second phase involves up to four site visits to conduct implementation and support for operators on procedures recommended to overcome those problems identified during the diagnostic phase. The visits occur over several months after the program is initiated at an Air Force installation. The team also validates the content of the draft O&M manual and examines operational problem areas in more depth.

The third phase, which occurs 6 to 12 months after the initial site visit, is a follow-up verification of plant performance to assess those improvements that have been made since the program was initiated and the benefits accrued. If needed, additional assistance that might benefit plant operators is provided.

## **1.2 PURPOSE OF PHASE I VISIT**

The Phase I visit was conducted to perform an on-site diagnostic evaluation of the Shaw Air Force Base wastewater treatment plant (WWTP). The purpose of the visit was to provide site-specific assistance to the WWTP staff to identify and correct deficiencies and less than optimum practices and procedures.

The Phase I on-site diagnostic evaluation of the WWTP was conducted during the period of April 25-29, 1994. Members of the ES Team included:

- Mike Hewitt - ES Project Manager
- Charles Baylot - ES Technical Manager

A kickoff meeting was held on the morning of April 25, 1994. An initial tour of the WWTP was conducted on the morning of the same day. Minutes of the kickoff meeting were provided in Letter Report No. 1, dated May 6, 1994.

During the period of April 25-29, 1994, the ES team members evaluated the operation and maintenance of the treatment facility. Several informal meetings were held between ES team members and plant personnel. Particularly involved in assisting the team members were:

- Chief Master Sergeant Willie Godfrey - Infrastructure Superintendent
- Mr. Gary Danner - Assistant Infrastructure Superintendent
- Mr. Furman Grooms - Utility Operations Supervisor
- Ms. Gail Dorr - Laboratory Technician
- MSgt. David Bartlett - Plant Operations
- SSgt. Frank Cabello - Plant Operations

An exit briefing was held on the morning of April 29, 1994. The meeting was presided over by Colonel DiRosario. A summary of the Phase I site visit and initial recommendations were presented by the ES team. Summary recommendations were documented in Letter Report No. 2, dated May 11, 1994.

## **1.3 ACCOMPLISHMENTS OF PHASE I VISIT**

During the Phase I visit, the evaluation team made a number of significant accomplishments. The major accomplishments include:

- Diagnostic evaluation of each unit treatment process.
- Evaluation of operating strategy.
- Evaluation of sampling, laboratory procedures and analytical equipment.
- Evaluation of physical condition of plant and equipment.
- Evaluation of preventive maintenance and safety programs.
- Evaluation of plant record keeping systems.
- Evaluation of operator job skills, certification levels, and training.
- Evaluation of management structure for the WWTP.
- Evaluation of the effect of nondomestic discharges on the WWTP.
- Inspection and evaluation of remote lift stations.
- Collection of information for the O&M manual
- Implementation of new sludge wasting procedure.

#### **1.4 INSTALLATION OVERVIEW**

Shaw AFB is located ten miles west of Sumter, South Carolina. The Base consists of approximately 3,360 acres. The areas immediately adjacent to the Base are primarily agricultural and residential. Shaw AFB is home to the 20th Fighter Wing of the Air Combat Command (ACC). The Base is also the headquarters of the 9th Air Force. The primary mission of the Base is to support the 20th Fighter Wing and the major tenant wings and various squadrons and detachments. There are a total of 6400 military personnel stationed at Shaw AFB and 1250 civilian personnel working at the Base. With dependents and retirees use of the Base, the daily on-base population is approximately 10,000. Industrial activities at Shaw AFB can be grouped into three general categories: aircraft and flightline maintenance, facility and transportation maintenance, and petroleum, fuels and lubricants operations. These operations are performed at locations throughout the base. It is estimated that less than one percent of wastewater discharged to the WWTP from the Base is industrial. This constitutes approximately 10,000 gallons per day of industrial flow.

The Shaw AFB WWTP and lift stations are operated by a combined staff of military and civilian operators. The treatment plant is located in the southwest quadrant of the

base. There are 12 sewage lift stations which are tributary to the base WWTP. These lift stations are located throughout the base.

## **1.5 OPERATING PERMIT REQUIREMENTS**

A primary objective of this WWTP Environmental Study is to ensure that the operation of the WWTP maintains compliance with the National Pollutant Discharge Elimination System (NPDES) Permit (SC0024970). The Shaw AFB WWTP discharges to Beech Creek tributary to the Wateree River. The NPDES Permit discharge limitations are presented in Table 1.1.

In addition to the criteria presented in Table 1.1, general operating requirements which should be followed are summarized below:

1. The plant should have a continuous recording flow monitoring system capable of measuring and recording the total and maximum daily flow. The calibration and accuracy of the plant flow meter must be maintained such that flows are measured with a deviation of less than 10% from the true discharge rate throughout the expected range of flows.
2. Monitoring results obtained each month shall be reported monthly on a Discharge Monitoring Report Form to the South Carolina Department of Health and Environmental Control (DHEC). The reports must be submitted no later than the 28th day of the following month.
3. Test procedures for the analysis of pollutants shall conform to the State Environmental Laboratory Certification Regulations and 40 CFR Part 136 Chapter 1, Subchapter D.
4. Records of monitoring data shall be maintained including the date, exact place, and time of sampling or measurement, the initials of the person performing the measurement, the dates and times the analyses were performed, a reference to the written procedure used and the raw data and final results of the analyses.
5. If monitoring of any pollutant is performed more frequently than required by the permit using approved analytical methods, the results shall be included in the calculations and reporting on the Discharge Monitoring Reports.

**TABLE 1.1**  
**Shaw AFB WWTP**  
**NPDES Permit Limitations**

Parameter	Units	30-Day Average	Daily Maximum	Daily Minimum
Flow	MGD	1.2	Monitor only	--
Biochemical Oxygen Demand (5-day)	mg/l	15	30	--
Suspended Solids	mg/l	30	60	--
Ammonia (NH <sub>3</sub> -N) (Mar-Oct)	mg/l	--	4.0	--
Dissolved Oxygen	mg/l	--	--	6.0
Total Residual Chlorine (TRC)	µg/l	--	100	--
Total Phenols	mg/l	Monitor Only	--	--
Fecal Coliform	Colonies/100 ml	1,000	2,000	--
pH	Standard Units	--	8.5	6.0

6. All record and information collected from the monitoring activities required by the permit including all records of analysis, calibration and maintenance of instruments and flow meters shall be retained for three years.
7. Non-compliance with provisions and limitations in the permit which may endanger public health or the environment must be reported to DHEC verbally within 24 hours and in writing within five days of becoming aware of such conditions. The report should include a description of the discharge and cause of non-compliance and the period of non-compliance including exact dates and times. Non-compliance of a nature not considered to be a danger to public health or the environment should be reported in a narrative form at the time of submittal of the Discharge Monitoring Report.
8. The WWTP shall at all times be properly operated and maintained, including all systems installed to achieve compliance with the permit. Proper operation and maintenance include effective performance in accordance with design criteria, adequate operator staffing and training, and adequate laboratory and process controls.
9. An operator shall be provided, as certified by the South Carolina Board of Certification for Environmental Systems Operators, with a grade equal to or higher than the classification designated for the plant. For the Shaw AFB, a minimum Class B operator is required.

## **1.6 SLUDGE LAND APPLICATION PERMIT**

The Shaw AFB WWTP has a Land Application Permit to apply digested, stabilized sludge to a 171 acre tract of forested land on the base. The permit contains requirements for monitoring of sludge, soil, and groundwater wells. The permit also contains operation and reporting requirements. A review of reports being submitted to DHEC on the sludge land application site indicates that the monitoring and reporting requirements are being adhered to. A visit to the site during the Phase I evaluation indicated that the site is being lightly loaded at the present time and there were no apparent problems.

## **SECTION 2**

### **PLANT DESCRIPTION**

#### **2.1 GENERAL**

The Shaw AFB WWTP is a biological treatment process achieving advanced secondary treatment levels utilizing the activated sludge process and tertiary filtration. The treatment plant's original design and construction date is unknown. The most recent major modification occurred in 1993-1994 with the addition of a new headworks, an equalization basin, a second chlorine contact chamber, dechlorination equipment, a third aerobic digester and the lime stabilization system for digested sludge.

#### **2.2 WASTEWATER CHARACTERIZATION**

The plant influent is primarily domestic and, although the industrial waste flow is not monitored, it is estimated that less than one percent of the wastewater is from industrial contributions. The influent wastewater to the treatment plant is characterized by an average biochemical oxygen demand (BOD) of 189 mg/l with a range from a low of 115 mg/l to a high of 271 mg/l. Influent total suspended solids (TSS) averaged 117 mg/l with a low of 37 mg/l and a high of 228 mg/l. These data were compiled from the period March 1993 through February 1994. These values are consistent with average, high and low values for influents to domestic wastewater plants in the United States.

The wastewater treatment plant is receiving an average influent flow of 1.215 million gallons per day (mgd). The range for daily influent flow during the period March 1993 through February 1994 was a high of 5.271 mgd and a low of 0.420 mgd. The average hydraulic loading to the WWTP is equal to the present design capacity of 1.2 mgd

#### **2.3 KEY TREATMENT PROCESSES**

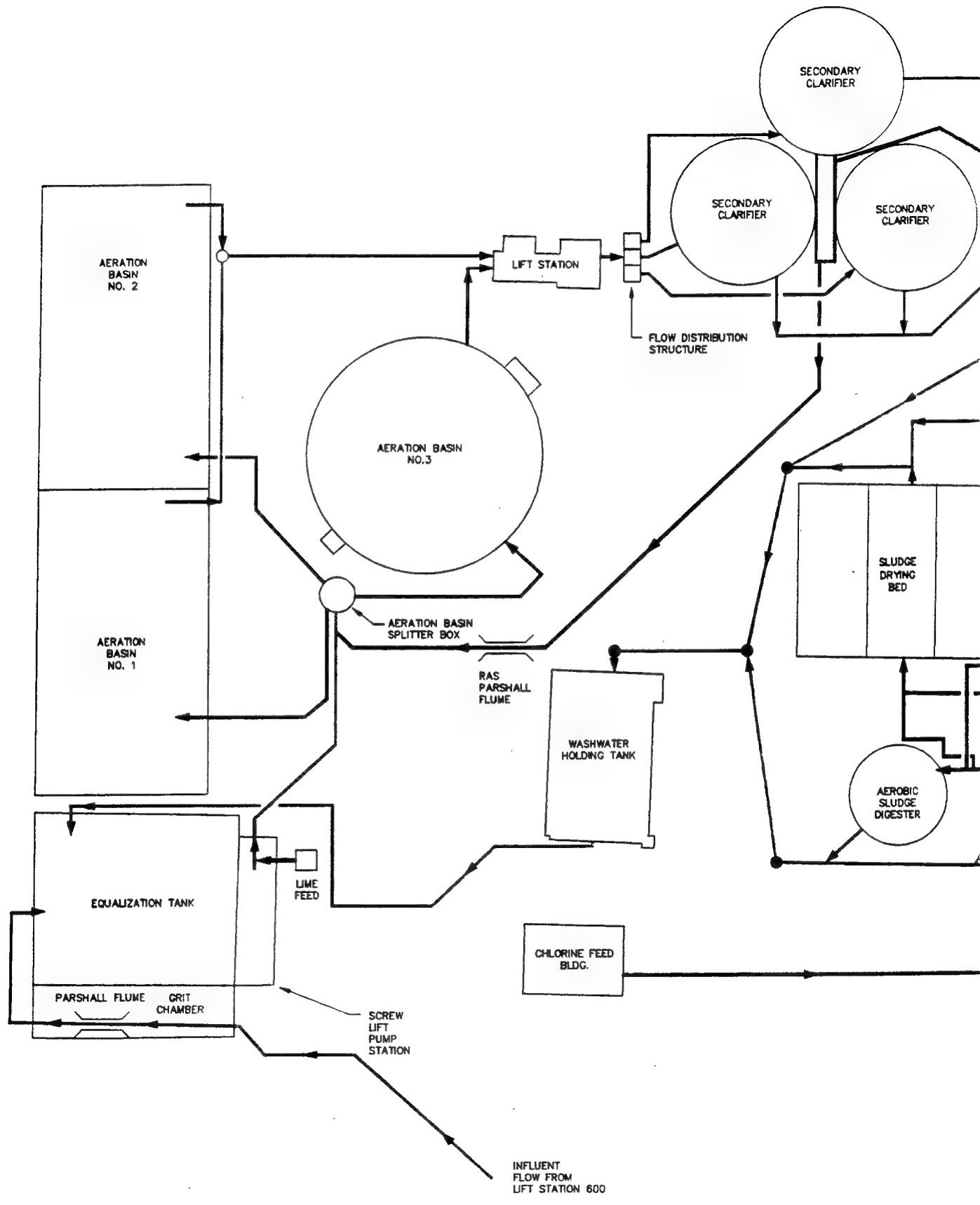
The Shaw AFB WWTP is a biological treatment system employing the activated sludge process. The key unit processes are:

- Screening

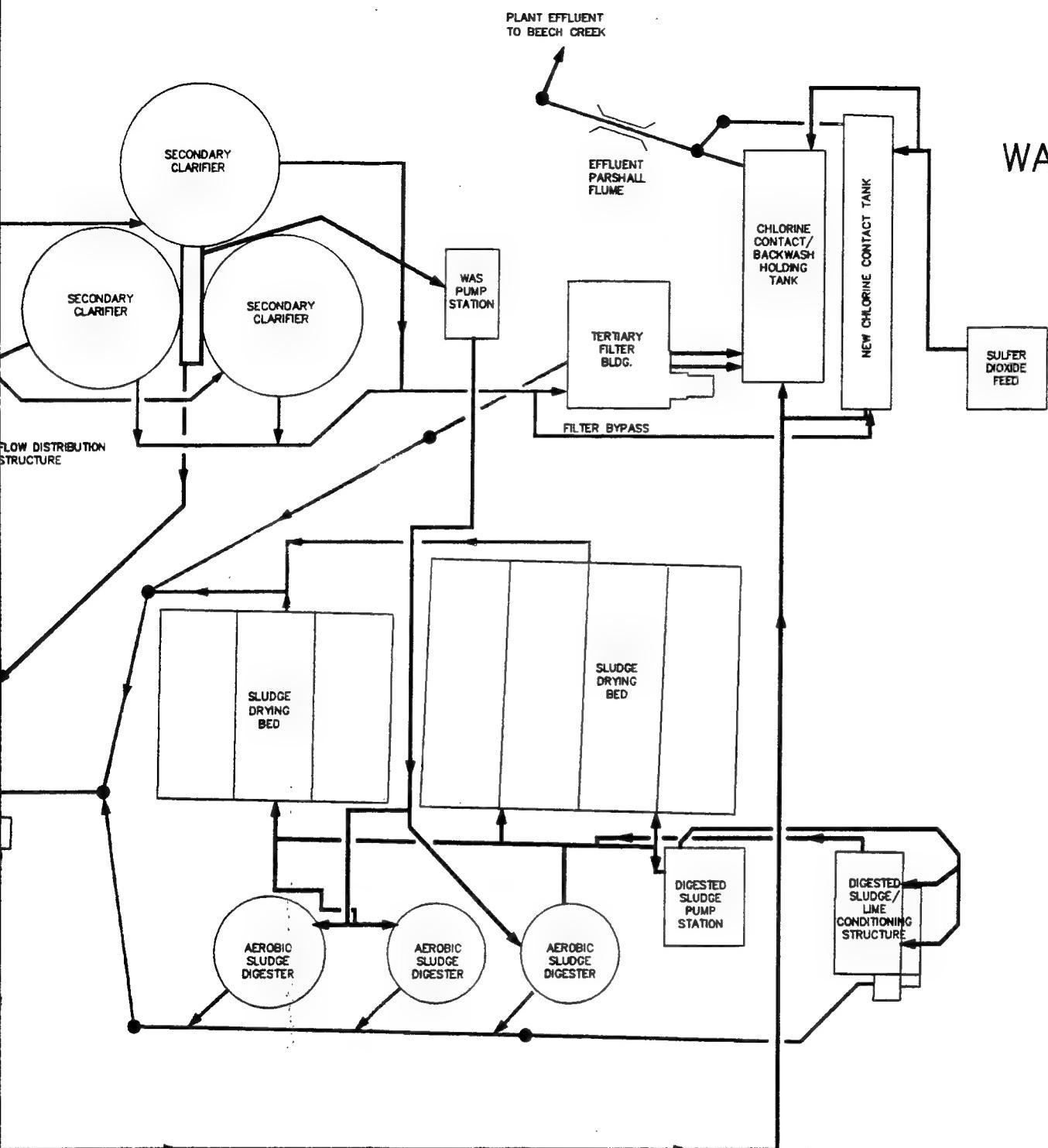
- Grit Removal
- Equalization
- Biological Treatment (Activated Sludge)
- Secondary Clarification
- Multi-media Filtration
- Disinfection (Chlorination)
- Dechlorination(Sulfur Dioxide)
- Aerobic Digestion
- Sludge Dewatering (Drying Beds)
- Lime Stabilization of Liquid Sludge
- Sludge Land Application

## 2.4 FLOW SCHEMATIC DIAGRAM

Figure 2.1 presents a schematic diagram of the Shaw AFB WWTP. Major plant unit processes and flow streams are identified in the schematic. A map of the land application site was unavailable during the Phase I on-site visit. A Figure will be included in the Final Phase I Report if available.



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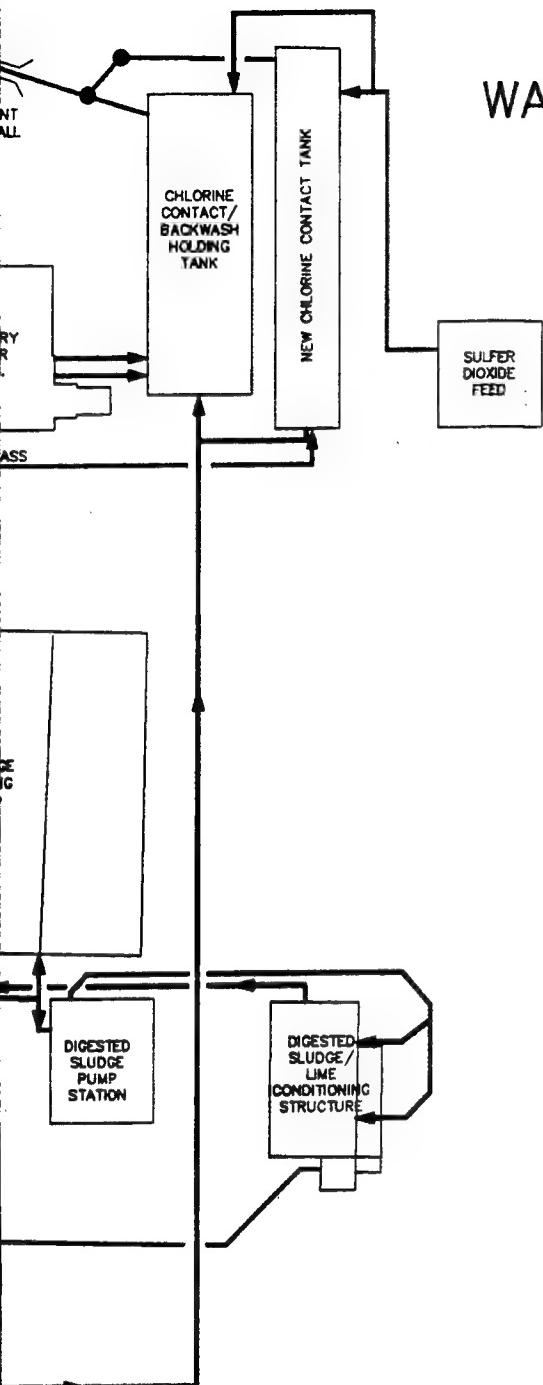


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Figure 2.1

FLOW SCHEMATIC  
SHAW A.F.B.  
WASTEWATER TREATMENT  
PLANT



LEGEND

- PLANT FORWARD FLOW
- SLUDGE FLOW
- CHEMICAL FEED
- BACKWASH/SUPERNATANT/  
UNDERDRAIN

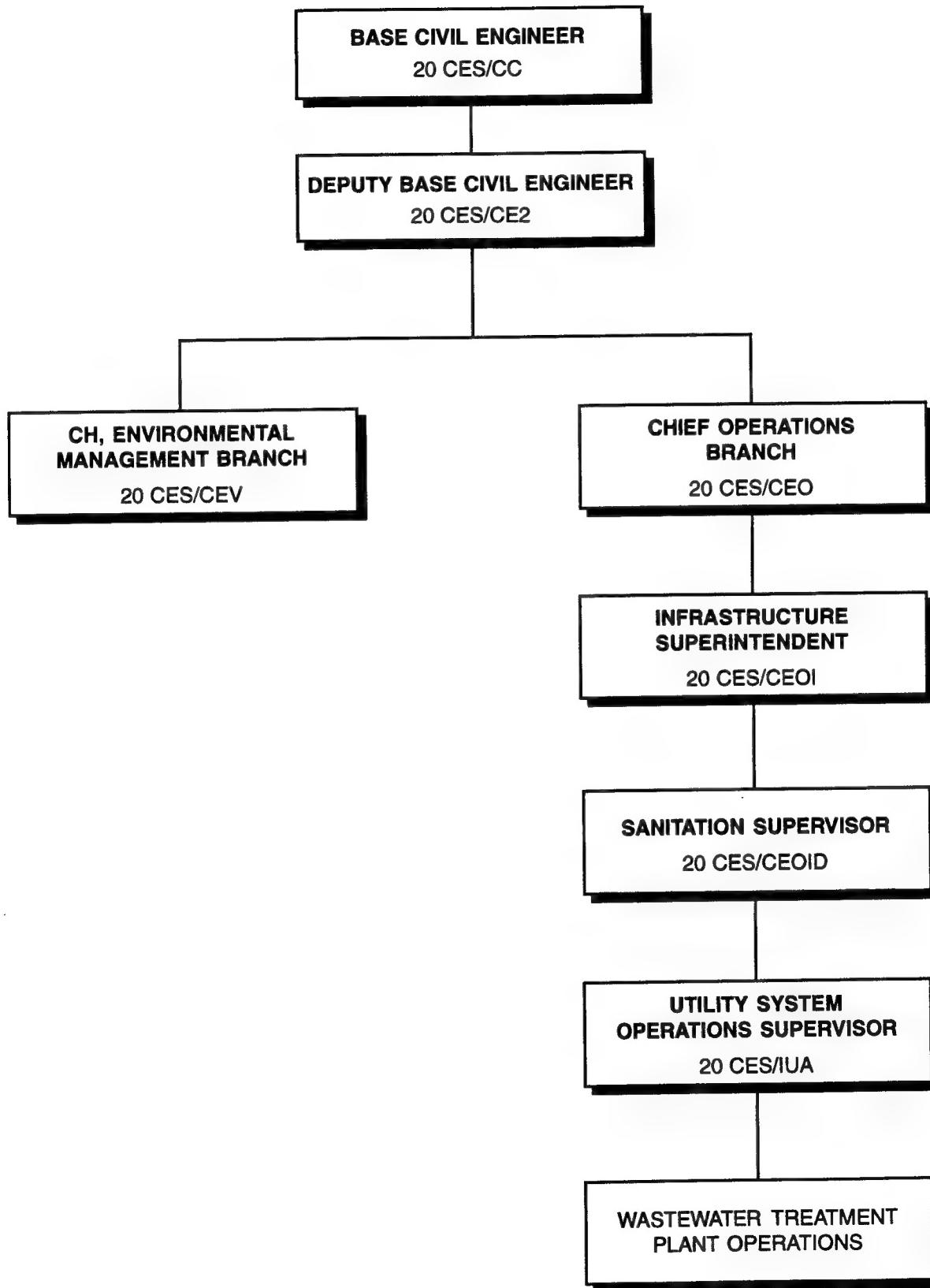
## **SECTION 3**

### **PLANT STAFFING AND MANAGEMENT**

#### **3.1 PLANT STAFFING LEVEL AND ORGANIZATION**

Currently the Shaw AFB WWTP is staffed by one Sanitation Supervisor, a Utilities Systems Operations Supervisor, four civilian plant operators, one maintenance mechanic, one laboratory technician and seven military utility operations specialists. The overall management of the wastewater treatment plant is directed by the Infrastructure Superintendent and Assistant Infrastructure Superintendent. The Assistant Infrastructure Superintendent has been a temporarily assigned position at the WWTP. This position will not be part of the WWTP structure after June 1994. Above those positions is the Chief of the Operations Branch of Civil Engineering. An organizational chart for the WWTP is provided in Figure 3.1. These personnel are responsible for staffing the plant 24 hours per day, seven days per week. In addition to the wastewater treatment plant and laboratory, the O&M personnel are responsible for twelve lift stations, six water booster pump stations that contain lime, fluoride and chlorine feeders, and three swimming pools. All wells and feeders are manually operated. O&M personnel are responsible for maintenance of all these facilities. It is estimated that all civilian operators spend approximately 60-65 percent of their time on activities related directly to the wastewater treatment plant due to their other responsibilities. The Maintenance Mechanic is approximately 50 percent available for plant maintenance. The military operators have approximately 75 percent utilization on water and wastewater O&M, of which approximately 65 percent is available for plant activities. The Infrastructure Superintendent and Sanitation Supervisor are approximately 50 percent available for plant O&M supervision after taking into consideration their off-plant responsibilities. This results in an approximate available manpower of eight full-time persons for the wastewater treatment plant.

## SHAW AFB WWTP ORGANIZATIONAL CHART



### **3.2 OPERATOR DUTIES**

The plant operators are all required to perform operational duties and minor maintenance functions. In addition some operators also perform minor, routine sampling and laboratory functions. The majority of scheduled preventive maintenance and equipment repairs is performed by the Maintenance Mechanic.

During Phase I, the ES evaluation team observed the plant operators in the execution of routine O&M and laboratory tasks. The operators performed their duties in an effective manner. The execution of routine duties was carried out in a manner dictated by operator experience. Operating guidance and some standard operating procedures are available at the plant in the current Operations and Maintenance manual. Process control strategies discussed in the O&M manual have been utilized to control the activated sludge process in the past with limited success. The manual contains some pertinent plant process descriptions and some detailed operation and maintenance SOPs. However, a great deal of the material is outdated due to the upgrading of the plant and the addition of the new plant equipment and processes. The manual needs considerable upgrading and establishment of current SOPs. These items will be undertaken in Phase II of the Shaw AFB WWTP Environmental Study beginning in July 1994. Other than the current O&M manual, plant operating procedures are dictated by operator experience. The plant has detailed procedures available for all components of sampling and laboratory analyses. Laboratory analyses procedures are available for all parameters for which the lab is certified under the state's laboratory certification program consist. The WWTP also has a set of detailed maintenance procedures and preventive maintenance schedules documented in the computerized Recurring Work Program(RWP). The RWP makes use of a file called the MAS sheet or Maintenance Action Sheet which provides a detailed listing of tasks to be performed for scheduled maintenance areas. In the area of operations, detailed checklists should be developed for items that need to be performed on each shift including a schedule of plant items to be checked, readings to be taken, samples to be collected and tests to be conducted. Check sheets would serve as an excellent format for items to be completed on each shift. Some of the information within current procedures could be adapted to a checklist format. This approach will be further explored and check sheets developed for the O&M Manual. (1.4.12)

### **3.3 CERTIFICATION REQUIREMENTS**

The Shaw AFB WWTP is an activated sludge wastewater treatment plant within the State of South Carolina and as such, must comply with the rules of DHEC and the South Carolina Environmental Certification Board. DHEC, in the NPDES permit issued to Shaw AFB, has classified the WWTP as a Class IIIB plant. A Class IIIB plant is required to have Class B domestic plant operator in charge. The WWTP meets this requirement. Mr. Grooms, the Utilities Operations Supervisor possesses a Class A domestic certificate. The requirements for obtaining a Class B certificate are as follows:

- Hold a valid "C" certificate in wastewater treatment
- Successfully complete a "B" level examination
- Have a minimum of three years of actual operating experience as an operator of a wastewater treatment plant

Each certificate issued by the Board of Certification must be renewed annually on or before June 30th. Each applicant applying for renewal of a wastewater treatment certificate must, in every two year period, provide evidence of having completed twelve hours of relevant continuing education. In lieu of continuing education, the applicant may take and pass the appropriate examination for his/her certificate of a higher grade.

### **3.4 ADEQUACY OF STAFFING**

Currently there are 14 O&M personnel for the Shaw AFB WWTP. As discussed in Section 3.1, the operators, laboratory technician, maintenance mechanic and supervisory staff have other duties related to the lift stations, water booster stations, and swimming pools and in the case of military personnel, training and readiness drills which reduce their total utilization time for plant O&M. Our analysis of these utilization factors indicate that there are the equivalent of seven and one half full-time O&M persons for the plant. Currently the plant operates 24 hours per day. The evening and night shifts utilize two persons each. One of those persons must perform the monitoring rounds for the lift stations and the water stations. It appears that the current staffing level is not sufficient to properly operate and maintain the facilities assigned to the utilities group under current operating conditions. There does appear to be opportunities where manpower savings could be made to increase the utilization of current personnel for O&M duties at the WWTP.

Although the ES evaluation team was not specifically charged with evaluating the water system, it was reported to the team on several occasions that the lime feed equipment at the water booster stations was a large drain on the operators' time due to frequent breakdowns and the need to clean the equipment to keep it operational. The need and feasibility of upgrading this equipment should be examined due to the demand on utility personnel resources. Also, from a O&M standpoint, there isn't a need to visit each lift station on every shift. The necessity on the evening and night shifts is to monitor the stations to ensure that they are operating properly. The base has some of the hardware already in place for a remote monitoring of lift stations and wells. Further hardware and software improvements are needed to tie the field monitors into the bases EMCS. This is planned as soon as manhours are available. The installation of such a system would improve personnel utilization efficiency.

### **3.5 ADEQUACY OF EXISTING DOCUMENTS**

As discussed in Section 3.2, the WWTP has an O&M manual. This document contains material on the plant as it existed prior to the upgrade completed in March of 1994. Standard Operating Procedures (SOPs) are for the most part lacking in this manual as are plant monitoring check sheets. These items will be incorporated into the new O&M manual developed as part of this project. The plant has a complete set of plans available at the WWTP which include the recent upgrade. The plant also maintains a current copy of the NPDES permit. The plant is in need of a new flow schematic diagram which shows all current processes and flows. Documents related to the plant maintenance program were complete. As discussed, the RWP program is being utilized for maintenance scheduling, records of repairs and replacement and equipment data. SOPs for maintenance are included in the MAS files. The plant maintains a complete set of manufacturer's literature on the plant and lift station equipment. SOPs available for laboratory analyses are complete for the analyses that the laboratory is certified to run. Excellent records are maintained of all required laboratory analyses data and calibrations.

The plant had a number of information files on the base-wide safety program. These included safety policy memos issued by the base and squadron commanders, procedures for reporting mishaps and injuries, general safety bulletins, required lists for personal protective equipment, emergency procedures, hazard identification procedures, lockout/tagout guidelines, employee safety and health records and safety briefing records. In the area of safety documents, the plant was in need of a weekly safety inspection checklist. (1.4.1.4)

### **3.6 EXISTING TRAINING PROGRAM**

There are no formal training programs available for the military operators at the Shaw AFB WWTP. OJT is the primary training mechanism used. Additional training is needed for the military operators to ensure that they all have a solid foundation in wastewater treatment concepts. This is particularly true in instances when new personnel begin working at the WWTP. The correspondence course "Operation of Wastewater Treatment Plants" offered by the California State University at Sacramento would be an excellent course. This course could be implemented for training of plant operators either in a correspondence, self-study format or by utilizing in-house instruction and supervised examination. This course could also be utilized for new civilian operators in the process of obtaining their initial wastewater training.

Outside seminars and workshops directly related to the Shaw AFB WWTP should be attended at least biannually by civilian plant personnel in order to obtain their continuing education units necessary for certificate renewal. Another useful training tool that is beneficial from a technical standpoint and also enhances management effectiveness is in-house training. In-house training seminars in wastewater treatment should be conducted for plant personnel by the Utilities Supervisor and Assistant Infrastructure Superintendent or designated senior operators. These seminars will increase the technical knowledge of the operations staff and provide a forum for discussion of operational issues at the WWTP.

It is also recommended that the following reference/training manuals be provided at the plant for operators to use for independent study.

- Sacramento Course - *Operation of Wastewater Treatment Plants*, Volumes 1 and 2.
- Sacramento Course - *Industrial Waste Treatment*
- Air Force Manual AFM 91-32 - *Operation and Maintenance of Domestic and Industrial Wastewater Systems*
- Standard Methods for the Examination of Water and Wastewater, 18th Edition
- Manual of Practice OM-9 - Operation and Maintenance of Activated Sludge Plants
- Manual of Practice 7 - Operation and Maintenance of Wastewater Collection Systems

- Manual of Practice OM-3 - Plant Maintenance Program
- Manual of Practice 11 - Operation of Wastewater Treatment Plants
- Manual of Practice OM-1 - Wastewater Sampling for Process and Quality Control

All of the above manuals of practice (MOP) are available from the Water Environment Federation and are normally available through the base library. (1.4.1.6)

### **3.7 MANAGEMENT EVALUATION**

The current management structure for the WWTP is adequate to meet the needs of the plant. There is a solid commitment on the part of upper management in the Civil Engineering Squadron and Headquarters of Air Combat Command (HQ/ACC) to making needed improvements to the plant. Funds have been allocated for this Wastewater Treatment Plant Environmental Study by HQ/ACC, and, in addition the plant recently received funding for a major upgrade. Earlier this year, an additional management position was allocated to the plant. The Assistant Infrastructure Superintendent position was allocated in an effort to improve management effectiveness at the WWTP until the Sanitation Supervisor position was filled. The Sanitation Supervisor position has been filled by Senior Master Sergeant Naven who recently arrived at Shaw AFB. This assignment will provide a NCOIC at the plant who is trained in management and wastewater treatment and will provide the most effective management scenario for the plant. A mechanism should be implemented whereby plant management meets on a regular basis with the operational staff to discuss operational strategies and issues of concern to the plant operators. At a minimum, weekly staff meetings should be held.

## **SECTION 4**

### **PLANT OPERATIONS/PROCESS CONTROL**

The Wastewater Treatment Plant (WWTP) receives primarily domestic wastewater generated at base housing, flight line maintenance shop, and administrative office buildings located throughout the Base. Non-domestic wastewaters generated at the maintenance shops are normally pretreated to remove floating oils prior to their discharge to the sanitary sewer.

#### **4.1 OVERVIEW OF THE TREATMENT PLANT**

##### **4.1.1 Collection System**

Wastewater flows by gravity to twelve lift stations located throughout the Base. These lift stations are:

- Station No. 0012 Shaw Drive Pumping Station
- Station No. 0116 Aero Club Lift Station
- Station No. T-28 Mobile Communications Bldg Lift Station
- Station No. 600 Main Lift Station
- Station No. 600 Old Main Lift Station
- Station No. 1130 9th Air Force Lift Station
- Station No. HQ Headquarters
- Station No. 1216 Aircraft Maintenance Lift Station
- Station No. 1600 AGE Maintenance Lift Station
- Station No. 3227 Old Wherry Housing Area Lift Station
- Station No. 5630 New Wherry Housing Area Lift Station
- Station No. 0306 WWTP Influent Pump Station

All lift stations are normally checked three times daily (once each shift) to detect unusual or excessive noise, vibration and overheating, and to ensure operation of the

station. Each of the lift stations was inspected by the evaluation team during the Phase I on-site visit. The condition of the pump stations was excellent. All pumps, controls, alarms, lights and other mechanical equipment was operational at the time of the Phase I on-site visit. The buildings and grounds are well maintained. Each lift station has at least two pumps and nine of the pump stations have automatic alternation of lead-lag pumps. One pump normally serves as a back-up during high flows. The majority of the pump stations are of the separate wet well and centrifugal pump arrangement. The remainder are submersible pump installations. All of the stations have some type of alarm, either a local audible alarm, or a light. Some of the stations are set up to have a signal telemetered by telephone line to a remote location. The main lift station is connected to the control panel at the WWTP.

Lift station No. 0012 is located off Shaw Drive near Park Pavilion. This station has two, 250 gallon per minute(gpm) submersible pumps . The pumps are activated by float controls. The pump station has both an audible alarm and alarm light. All pumps and equipment were operational and this station was in excellent condition.

Station 0016 is located beside the Base Aero Club. The station contains two, 250 gpm centrifugal pumps. The station contains a separate wet well. The motors are located top-side and are coupled to the pumps by long shafts and universal joints. The pumps are controlled by floats in the wet well and the lead-lag status of the pumps alternates automatically. All pumps and equipment were operational and this station was in excellent condition.

Station T-28 is located inside the heat control room of T-28. This station contains two, 150 gpm centrifugal pumps. The station has a separate dry well and wet well. The motors are top-side and are coupled to the pumps by a long shaft. The pumps are controlled by floats inside the pump station wet well and pump alternation is automatic. Station T-28 is equipped with an audible alarm. All pumps and equipment were operational and the general condition of the station was excellent.

Station 600 is located on Lance Street on the same lot as the old 600 lift station. This is the main lift station within the collection system. The station contains three, 1800 gpm submersible grinder pumps. All pumps and equipment at this station were operational. The pumps operate off a float control system. The station has a macerator and a manual bar screen. There is an emergency power generator at this station. All

back-up equipment is exercised quarterly. The station has audible and alarm lights for power failure. Two of the pumps are set up for automatic alternation.

Old Station 600 now serves as a back-up station. The Station is located on the corner of Lance Street in the same lot as the new 600 station. The station contains two, 600-2500 gpm non-clog centrifugal pumps. There are separate wet and dry wells. The motors are mounted top-side and are coupled to the pumps by long shafts and universal joints. The pumps are controlled by a bubbler control system and there are light and audible alarms for power. This station does not operate under normal conditions. It serves as a backup to the new station. All equipment at this station was operational and the overall condition of the station was excellent.

Station 1130, the 9th Air Force Lift Station, is located behind Building 1133. This is a below ground station with separate dry and wet wells. The station contains two, 100 gpm non-clog centrifugal pumps. The pumps are controlled by probes in the wet well. There are both audible and alarm lights alarms for power failure. All pumps and equipment were operational at the time of the Phase I evaluation and the condition of this station was excellent.

The HQ Lift Station is at Building 517 at 517 Lance Street inside the maximum security section of the facility. The station contains two, 250 gpm submersible grinder pumps. The pumps are controlled by floats and the station has an audible alarm. All pumps and equipment were operational at this station and the general condition of the station was excellent at the time of the Phase I evaluation.

Station No. 1216, the Aircraft Maintenance Lift Station, is located off Killian Avenue. The station contains two, 150 gpm, non-clog centrifugal pumps which are controlled by floats. The station has an audible alarm for power failure and has phone hook up capability for transmitting a signal to a remote location. All pumps and equipment were operational at the time of the evaluation and the condition of the lift station was excellent.

Station 1600, the AGE Maintenance Lift Station, is located inside AGE Maintenance yard. The station contains a separate wet and dry wells and has two, 250 gpm non-clog centrifugal pumps. There is an audible alarm at the station and phone connection is available for transmitting a signal to a remote location. All equipment and pumps were operational and the condition of the station was excellent.

Station 3227, the Old Wherry Lift Station, is located in the old Wherry Housing area. This station is equipped with an outside comminutor. The station has a separate wet well and dry well with two, 250 gpm non-clog centrifugal pumps. The pumps are controlled by a float control system. The station has an audible alarm and a connection for transmitting a signal by telephone line to a remote location. All pumps and equipment were operational and the station was in excellent condition.

Station No. 5630, New Wherry Lift Station, is located at the end of Persimmon Street. This is a below ground station. The station contains a separate wet and dry well. There are two, 454 gpm direct drive, non-clog centrifugal pumps. The station has an audible alarm and automatic alternation of pumps. The pumps are controlled by a bubbler system. All pumps and equipment were operational and the station was in excellent condition.

All remote lift stations have hook-ups where an emergency generator can be plugged in if needed. Potable generators are located on base for such a use.

Station 306, the WWTP Lift Station is located within the treatment plant between Aeration Basin No. 2 and the secondary clarifiers. This station has a wet well and dry well and top side motor coupled to the pumps by long shafts and universal joints. The two new pumps are variable speed 0-2500 gpm centrifugal pumps. The station also has one 0-1200 gpm and two 250 gpm centrifugal pumps. The station has an audible and alarm light at the main control panel. The general condition of the station was good. One of the new pumps was out of service at the time of the evaluation due to vibration problems. This station has an emergency power generator available to maintain forward flow through the plant during power outages.

#### **4.1.2 Oil/Water Separators**

On base there are a total of 28 oil/water separators which collect oily wastewater from maintenance shops on the flight line and throughout the base. The majority of the oil/water separators are manual in operation. The manual operation units collect oily wastewater, retaining the oil and allowing water to flow through into the sanitary sewer. The oil accumulates in the units and must eventually be pumped out by a contractor. Eight of the units have pumps which are controlled by an oil interface probe. When oil reaches a pre-set level, the pump is activated by the probe and pumps oil into an adjacent holding tank. At two locations, Buildings 1602 and 1610, there are pumps for delivering fuel to the oil/water separator. Following is a list of base oil/water separators, their

locations and capacities. Outside contractors are responsible for the removal of oil and personnel at each building are responsible for maintenance of the units.

**Table 4.1 Base Oil/Water Separators**

<b>Separator No.</b>	<b>Location</b>	<b>Capacity, Cubic Ft.</b>
01	Bldg. 325 SW Corner	45
02	Bldg. 325 SW Corner	45
03	Bldg. 325 Middle Separator	45
04	Bldg. 343 Washrack at POL	108
05	Bldg. 339 Roads & Grounds	54
06	Bldg. 1031 Hobby Shop	54
07	Facility 30-Salvage Yard	54
08	Bldg. 105-Flightline (Old AGE Bldg.)	54
09	Bldg. 118 by Washrack - POL Yard	54
10	Bldg. 118 NE Side POL	36
11	Bldg. 706 Vehicle Washrack Fire Dept.	45
12	Bldg. 706 Fuel Pit Across From Fire Dept.	90
13	Facility 914 POV Washrack Behind Chapel	45
14	Bldg. 1301 Gas Station/Beside Lake	54
15	Bldg. 1206 Jet Engine Shop	120
16	Bldg. 1504 Small Portable Bldg. Removed from AcFt Washrack	720
17	Scum Box 1504	240
18	Bldg. 1511 North End	250
19	Bldg. 1511 South End (Fuel Cell Repair Bldg.)	250
20	Bldg. 1602 AGE Bldg.	90
21	Bldg. 1602 Fuel Pit by Flightline	90
22	Bldg. 1610 on Flightline N. End	90
23	Bldg. 1614 Flightline Hanger	320
24	Bldg. 1817 Bomb Dump	12
25	Bldg. 1855, 682 ASOC	384
26	Bldg. 1720 Fuel Tank Storage Area	320
27	Bldg. 1705 Test Cell, Adjacent Fence	90
28	Bldg. 1696-1697 Hush House	96

Units 9, 15, 16, 18, 19, 21, 22 & 25 contain a pumping system for removing oil to a separate storage tank.

### **4.1.3 Preliminary Treatment**

#### **4.1.3.1 Grit Removal**

Raw wastewater is pumped from Lift Station 600 and enters the treatment plant through a 14-in pipe. Influent flow enters the new grit chamber structure and flows through the aerated grit chamber. The chamber is 23 feet long by 4.5 feet wide and has a water depth of 5.5 feet for a total volume of 4,250 gallons. At design flow the hydraulic retention time in the grit chamber is approximately five minutes. The grit chamber is equipped with two blowers and air diffusers for supplying air. Grit is removed from the bottom of the chamber by a motorized collector with buckets mounted on a drive chain. The buckets pull grit toward a collection sump at the influent end of the chamber. The grit is picked up from the sump by the grit screw conveyer and deposited in the grit dumpster.

At the time of the Phase I evaluation, the grit removal system was not functioning properly. All the equipment was operational but little or no grit was being picked up by the conveyor and deposited into the dumpster. As discussed with operations personnel at the time and later in Letter Report No.2, the grit removal system needs troubleshooting to determine the reason for the operational deficiencies and the needed correction actions. The following troubleshooting steps will be initiated as soon as manhours are available for this project:

- When this system is in full operation and no grit falls into the grit hopper, several things need to be looked at to improve the operation of the system. It is possible that there is no grit to remove. Samples should be taken at several locations and settled in an Imhoff cone to determine that grit is present. The primary sampling points should be at the inlet and outlet of the grit chamber. The amount of grit found at both locations should be recorded over a period of about 7 days. If little or no grit is detected, grit samples should be taken upstream of the grit chamber at the influent to Pump Station 600. This will determine if grit is settling in the influent lines.
- If grit is found at the inlet to the grit chamber, the next step would be to ensure the grit collector and the grit conveyor are working properly. This can be done by removing the covers of these two devices and observing the operation for a short period of time.

- It is also possible that the grit buckets are not close enough to the floor of the grit chamber to pick up the grit. This can only be observed by bypassing the flow to the grit chamber and pumping the channel dry. If large deposits of grit are observed, then the grit buckets are too high.
- A fourth possibility is that too much air is being added, creating excess turbulence that keeps the grit in suspension. The only convenient method to control the flow of air is to pinch down on the blower discharge valve. This has been tried at Shaw AFB with no apparent change in turbulence. A second means to lower air flow would be to tap the discharge air line and add a vent to bleed off some of the air flow. In this instance, the vent line should be piped so the air would be discharged underwater to prevent excessive noise and provide a useful purpose for the vented air.
- Another option would be to tap the larger air header supplying air to the equalization basin and furnish air to the grit chamber from this line. The air pipe added should be equipped with a throttle valve to reduce the air to the required flow. This would allow discontinuing use of the two present grit blowers. A determination would have to be made if there is enough air produced by these larger blowers to supply both sources. None of these changes should be attempted until it has been determined that grit is reaching the plant headworks.

Forward flow continues from the grit chamber to the nine inch Parshall flume. Water level is sensed in the stilling well of the flume by a float and a signal is transmitted to the plant control panel, converted to flow data, recorded and totalized.

#### **4.1.3.2      Equalization Basin**

Pretreated influent wastewater flows to the plant equalization basin. The equalization basin dampens flow and concentration spikes to the treatment plant by providing an in-line reservoir for storage of wastewater. The equalization basin is 54 feet by 54 feet and 16.5 feet deep with an approximate volume of 350,000 gallons. The basin volume is capable of holding approximately eight hours of average daily flow. The equalization basin is equipped with two, 388 cubic feet per minute centrifugal blowers for aerating and mixing the influent wastewater through a grid piping and diffuser system. Currently this basin is being operated to maintain the lowest level possible

during dry weather. This allows maximum volume for dampening hydraulic peaks during high flow periods or for containing and equalizing contaminant spikes.

#### **4.1.3.3 Influent Pump Station**

Adjacent to the equalization basin is the new screw lift pump station and wet well. Wastewater from the equalization basin flows to a flow distribution box which contains two 18 inch sluice gates. These gates control flow to the suction side out of the screw pumps. An 18 inch invert and two channel sluice gates allow wastewater to flow to the suction side of the screw pumps. The two, 1425 gpm capacity screw pumps lift the influent wastewater to a channel and gravity line which flows to the aeration basin splitter box. The motor controls for the screw pumps are equipped with variable speed drives which were not being utilized. Operations personnel indicated that training was not received from vendors or manufacturer's representatives on this equipment during the upgrade. Preliminary tests indicate that these units are connected and appear to function. The variable speed capability of the influent screw pumps could be a critical part of the operation of the equalization basin. At present, one pump is being run on full speed and the pumping rate is controlled by controlling the height of the slide gate on the suction side of the pump. It is recommended that vendor training be provided to the operations staff so that the variable speed drives can be utilized. At present, the inlet sluice gates are positioned to allow the equalization basin to pump down at periods of low flow to allow sufficient space for water at high flow periods. This allows for a steady flow to reach the plant at all times.

At the upper elevation of the screw lift pumps, flow is discharged into an open channel. Lime is added to the waste stream at this location to ensure that the activated sludge process has sufficient alkalinity for nitrification and to ensure that effluent pH is not reduced below permit limitation. The lime feed system in use at the time of the evaluation was inadequate. Based on a background wastewater alkalinity of 120 mg/l approximately 275 pounds of lime per day are required for nitrification to proceed in the aeration basin without depressing the effluent pH. To be able to adequately feed that quantity of lime will require setting up a more permanent system. We recommend that the base obtain a 1500 gallon tank, a metering pump capable of pumping at least one gpm and a mixer that can be attached to the tank. The pH of the aeration basin consistently runs below 7.0 and has been measured as low as 5.9. 5.0 is considered too low for most bacteria to survive. A pH of 7.0 should be maintained for best results. At

the writing of the Final Phase I Report, a statement of work was being developed to replace the lime feed system by contract (1.4.1.1).

#### **4.1.4 Aeration Basins**

The WWTP is provided with three aeration basins for the biological treatment of organic wastes. The pretreated and equalized influent flows to the aeration basin splitter box where it is mixed with the return activated sludge before entering the aeration basins. The combined aeration basin volume is approximately 1.0 million gallons (MG). Aeration Basins Nos. 1 and 2 are rectangular basins each having a volume of 377,000 and Aeration Basin No. 3 is a circular basin and has a volume of 246,000 gallons. The aeration basins are equipped with surface mechanical aerators. The rectangular basins each contain two 25 horsepower surface mechanical aerators. Basin No. 3 contains one 30 horsepower surface mechanical aerator. The current loading rates to the system are as follows:

Volumetric Organic Loading Rate	11.9 lb BOD/1,000 ft <sup>3</sup>
Hydraulic Retention Time	20 Hours
Food/Microorganism (F/M) Ratio	0.05 lb BOD/lb MLVSS

The volumetric organic loading rate is in the lower end of the recommended range for extended aeration activated sludge systems (i.e., 10 to 25 lb BOD/1000 ft<sup>3</sup>). Similarly, the F/M ratio is in the lower end of the recommended range for extended aeration activated sludge plants(i.e., 0.05-0.15 lb BOD/lb MLVSS). The Hydraulic Retention Time is also on the lower end of the recommended range for extended aeration plants (18-36 hours): None of these loading factors are in a problem range as far as treatment efficiency or plant performance.

##### **4.1.4.1 Control Strategy**

The primary process control strategy which had been utilized at the Shaw AFB prior to the Phase I on-site visit was the maintenance of a constant mixed liquor suspended solids. Through operator interviews, it was determined that plant personnel have attempted to maintain approximately 30,000 to 34,000 pounds of MLSS in the aeration basins. This equates to approximately 3,600 to 4,000 mg/l. Part of the problem in the past has been that periodically, not enough sludge has been wasted. This coupled with the hydraulic peaks that reached the clarifiers prior to the installation of the equalization basin, resulted in wash out of solids, blinding of the tertiary filters and effluent permit

violations. Sludge should be wasted on a daily basis from the activated sludge system. During the Phase I evaluation, a sludge wasting strategy was introduced to the plant staff and discussed at length with key plant personnel. The proposed strategy is wasting sludge to maintain a constant sludge retention time(SRT). Using SRT as the main process control tool allows operators to waste sludge in a logical manner. SRT expresses the average time that the microorganisms spend in the activated sludge system. It is important that the proper SRT is selected because SRT determines the types of microorganisms that predominate in the system which relates directly to the degree of nitrification which will occur. For the Shaw AFB WWTP, a 22 day SRT has been selected initially. Twenty two days has been established as the optimum SRT after reviewing the current plant O&M manual and the 1986 engineering report produced for the upgrade. A SRT of 22 days should produce a nitrified effluent at the Shaw AFB which is a requirement of the discharge permit.

Following is the methodology for wasting the appropriate quantity and volume of activated sludge to maintain a 22 day SRT. This methodology has already been initiated by the plant staff on a daily basis with reported success.

1. Calculate the volume of sludge to be wasted each day. The formula to accomplish this is:

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Solids Inventory in the Activated Sludge System

Desired SRT X WAS Conc, mg/l X 8.34 lbs/gal

2. Determine the solids inventory in the activated sludge system. This is a three step process

a. lbs of solids in aeration = MLSS, mg/l X 1.0MG X 8.34 lbs/gal.

b. lbs of solids in clarifiers = Avg. solids, mg/l X Sludge vol. MG X 8.34

where: Avg solids, mg/l =  $\frac{\text{MLSS, Conc mg/l} + \text{RAS Conc, mg/l}}{2}$

Sludge vol, MG=Sludge Blanket, ft X Clarifier Area, ft<sup>2</sup> X 7.48gal/ft<sup>3</sup>

- c. Sum the pounds of solids in aeration and the pounds of solids in the clarifiers to obtain the total solids inventory in the activated sludge system.

3. Convert the pounds of solids to be wasted each day into gallons.

$$\text{WAS, gallons} = \frac{\text{Solids inventory in Activated Sludge System X } 1,000,000}{\text{Desired SRT X WAS conc, mg/l X } 8.34 \text{ lbs/gal}}$$

#### 4.1.4.2 Dissolved Oxygen Control

Dissolved oxygen(D.O.) is another critical process parameter which must be monitored and controlled to the greatest extent possible. D.O. should be monitored in each aeration basin during each shift. The basin D.O.s should never be allowed to drop below 2.0 mg/l. The minimum D.O. requirement of 2.0 mg/l applies to all segments and depths of the basins. To ensure that D.O. is consistent throughout the basins, D.O. profiles should be made of each basin once per quarter. Control of D.O. in the basins is limited to two operational approaches. One is to raise or lower the liquid level in the basin thus decreasing or increasing the "bite" of the aerator blades in the mixed liquor. The other is to lower the mixed liquor concentration if sufficient D.O. cannot be imparted to the basin. (1.4.1.1)

#### 4.1.5 Secondary Clarifiers

Three circular secondary clarifiers are provided for the settling of biological sludge. The effluent of the aeration tanks flows to the in-plant pump station. Station 600 lifts the forward flow to the Flow Distribution Box. This structure splits the flow and distributes the mixed liquor to the secondary clarifiers for settling. The distribution structure consists of an elevated rectangular concrete box and three outlet chambers which discharge flow into the inlet pipes for the clarifiers. The clarifiers are 35 feet in diameter and have a SWD of 8.5 feet. The side water depth is 1.5 ft. below most minimum recommended design criteria. This difference can have a profound effect on the performance of the clarifiers if other operating and design conditions are less than optimum. Observation of the clarifier weirs during the evaluation indicated level problems in several locations. Levels should be determined of the weirs in all clarifiers and corrections made where necessary. The surface skimmers appeared to be in need of repairs in all three units, also. A collection trough around the perimeter of each clarifier receives effluent which flows to the tertiary filters. The return sludge flow is controlled by three telescopic valves, one per clarifier. The underflow rate for each clarifier is increased or decreased by manually lowering or raising the telescopic valves. Return sludge gravity flows from the telescopic valves to the aeration basins. Waste sludge gravity flows to the WAS pump station wet well and is pumped to the aerobic digesters via the WAS pumps. WAS flow rates are currently estimated using the rise in level inside the digester being utilized. A flow meter is needed on the WAS line to optimize

sludge wasting and process control of the activated sludge system. WAS flow is a critical component of the constant SRT methodology recommended. Return sludge rates are currently in the range of 50-100 percent of influent flow. This is the correct range for the RAS if it adequately controls the sludge blanket depth in the clarifiers. At the time of the evaluation, sludge blanket depths were not being measured. It was recommended to the operational staff that a sludge blanket finder("sludge judge") be purchased and sludge blanket measurements be taken once per shift for each clarifier. This information is needed also in estimating the solids inventory in the secondary system for the purpose of calculating wasting rates.

Current available surface area for the three units combined is 2,886 ft<sup>2</sup>. Current available volume is 183,600 gallons. Operating parameters for the secondary clarifiers under average flow conditions of 1.20 MGD area as follows:

Surface loading rate	416 gpd/ft <sup>2</sup>
Solids loading rate	13.2 lb TSS/ft <sup>2</sup> -d
Hydraulic retention time	3.7 hours

The surface loading rate, hydraulic retention time and the solids loading rate are all within recommended design values.

#### **4.1.6 Tertiary Filters**

Secondary clarifier effluent gravity flows to the tertiary filters. Flow enters the filters through a 16 inch cast iron pipe into the forebays and across the filter surface. The filters are multi-media units with a total filter bed depth of 3.67 feet. The top layer of filter media, 24 inches of anthracite is on top of 8 inches of sand followed by 12 inches of graded gravel. The media rests on a precast filter bottom. Filter effluent is collected in the filter bottoms and flows out of the filters through a 16 inch line to the chlorine contact chamber. Entering the filter bottoms is a 14-inch backwash line. During filter backwashing this line is fed from a 2500 gpm backwash pump which uses the old Chlorine Contact Chamber contents for washwater. Backwash waste exits the filters via the wash troughs and is routed by 16 inch pipe to the backwash holding tank. From the backwash holding tank it is pumped to the equalization basin. The system was originally equipped with a surface wash system consisting of a 115 gpm surface wash pump and surface agitators fed by a 3 inch surface wash line. This system has not been in service for some time due to problems with the surface sweeps. The filters as a whole have had

operational problems in recent years requiring frequent bypassing. The system is operated manually at the present but at one time had an automatic backwash cycle initiated by head loss across the filters.

The filter operational problems have historically been associated with too high a solids loading during biological process problems and hydraulic wash outs of solids from the activated sludge system. At present the filter media appears to be bound tightly with old solids. Backwashing does not improve the condition of the media to any great extent. In addition, the lack of an operable surface wash system leaves the upper layer of media with a nearly solid surface. The ES evaluation team was told by plant personnel that the filter media had not been changed in over five years. In order to return the filters to an effective operating condition, the following items must be accomplished:

1. Properly operate the activated sludge system to avoid large losses of biosolids from the secondary clarifiers and overloading of the filters.
2. Replace the media in the filters as soon as possible and thoroughly clean out the bottom of the filters.
3. Repair or replace the filter surface sweeps to ensure that the top layer of media in the filter is broken up and cleaned during the backwash cycle.
4. Develop an operating strategy by maintaining records of critical data during filter runs and backwash cycles. The following data should be collected and analyzed so that backwash cycle times are correct, media problems are detected and performance efficiency of the filter is known:
  - Identify filter by number
  - Determine the inlet and effluent TSS to filters daily
  - Record time filter was placed in service
  - Record start time of filter backwashing
  - Record starting differential pressure of a filter run
  - Record stop time of filter backwashing
  - Record end differential pressure of a filter run
  - Record the time filter is put back in service
  - Record time duration of backwash

- Record hours filter is in service since previous backwash

Normal operating strategy should be to operate the filters until a back pressure is reached that prevents the plant flow from easily passing through the filter. At this point the filter should be thoroughly backwashed. The hours between backwash cycles will decrease as the filter media becomes contaminated, indicating a need to inspect and/or replace the media. Proper backwashing should allow the filters to run for up to a year (and sometimes longer) before media replacement is required. It is considered good practice to inspect the media in at least one cell every year. This allows for detection of problems before they become major.

#### **4.1.7 Chlorine Contact Chamber**

The WWTP is equipped with two chlorine contact chambers. The old contact chamber is 60 feet by 20 feet and has a working depth of 6.5 feet for a total capacity of 58,000 gallons. The hydraulic detention time is approximately 1.4 hours at current average flow rates. One baffle wall directs the flow in a side to side pattern in the chamber. At the current average flow of 1.2 MGD, this basin has a more than adequate hydraulic retention time. At the influent end of the basin, the backwash water pump and the surface wash pump are mounted and their suction pipes extend into the basin. A PVC chlorine diffuser pipe extends into the contact basin approximately 20 feet from the influent end of the chamber. At the beginning of the evaluation, the depth of the diffuser pipe under the surface was approximately 2 feet. One problem resulting from filter backwashing was that the capacity of the backwash pump, being greater than the flowrate into the contact chamber, resulted in the level of the contact chamber dropping below the level of the chlorine diffuser. This problem was discussed with plant personnel during the evaluation and the depth of the diffuser pipe was changed. The diffuser should always remain submerged due to the potential of chlorine gas vaporizing in the atmosphere, creating a hazard for plant personnel and plant neighbors.

The old chlorine contact chamber also contains two air diffusers near the effluent end of the tank for the purpose of adding dissolved oxygen to the plant effluent. The diffusers are supplied by an air blower in the filter control building. The blower has a capacity of 250 CFM. Also at the effluent end of the old chlorine contact chamber is a sulfur dioxide diffuser. Sulfur dioxide is added to the chamber just prior to the flow entering the outlet weir box of the chamber. Treated effluent flows out of the chamber

through the outlet weir box , to the effluent Parshall flume and through the effluent sewer to the plant outfall.

The new chlorine contact chamber is 75.5 feet in length by 11 feet wide by 8 feet of operating depth for a total capacity of approximately 50,000 gallons. At current average daily flow rates, the hydraulic retention time is approximately one hour. The chamber is equipped with a chlorine diffuser at the influent end of the tank and a sulfur dioxide diffuser at the effluent end of the tank. The new chlorine contact chamber was installed primarily to serve as a back-up tank to be utilized when it becomes necessary to bypass the tertiary filters. Inlet piping, however, does not allow use of this tank when the filters are in normal operation. When the filters are in use, piping can only route flow to the old contact chamber. This situation should be rectified. From the point of view of the evaluation team, this chamber should be used as the primary chlorine contact tank because of its newer design and the fact that it is not affected by filter backwashing. We recommend that piping modifications be made to allow this chamber to be used to treat plant flow under normal operating conditions.

Chlorine gas is fed through a 200 pound per day, wall-mounted chlorinator from 150 pound chlorine bottles. The chlorinator is located in the old laboratory building. Sulfur dioxide is fed by two 50-pound per day gas feeders. An average of 40 to 50 pounds per day of chlorine gas and sulfur dioxide is being fed to disinfect and dechlorinate the effluent and is resulting in an average maximum chlorine residual in the effluent of 210 µg/L. By the time the effluent reaches the outfall, the effects of the sulfur dioxide have further reduced the chlorine residual. Dechlorination and measurement of chlorine residual at the outfall did not begin until early 1994.

Chlorine gas and sulfur dioxide feed control are manual. The plant operators take plant effluent samples which are analyzed for Total Chlorine Residual. These data are used to make adjustment in the chlorine and sulfur dioxide feed rates.(1.4.1.1)

#### **4.1.8    Aerobic Digesters**

The Shaw AFB WWTP is equipped with three aerobic digesters. Each unit has a surface area of 490 ft<sup>2</sup> and a 18-ft SWD for a unit volume of approximately 65,000 gallons. The total volume of the three units is 195,000 gallons. Diffused air is provided to maintain aerobic conditions and mixing level requirements by positive displacement blowers. Two of the digesters were part of the plant prior to the recent upgrade and the third unit is new. The old digesters' blowers are located in the blower room on the lower

level between those units. There are two, 250 CFM units. The two new digester blowers are adjacent to the new digester mounted on an outside slab. These units are 240 CFM positive displacement blowers. Air is delivered by piping and 12 inch static tube aerators arranged in a grid on the bottom of the digesters. Each digester is equipped with 12 aerators. Each digester is also equipped with a new decanting weir for drawing supernatant. The decanting weir can be lowered on a worm gear to the level of the supernatant.

Average daily waste activated sludge flow to the digesters was approximately 8,000 gallons during the 12 months prior to the Phase I site visit. Average waste sludge concentration is approximately 7,500 mg/L. Therefore, the current loading factor is approximately 0.019 lb TSS/ft<sup>3</sup>-d. This loading level is below the design range for aerobic digesters (i.e., 0.024-0.14 lb solids/ft<sup>3</sup>-d).

Procedures for operating the aerobic digesters need to be established. The digester operation should be controlled based on the percent reduction in volatile matter. The target should be forty percent. The formula for calculating percent reduction across the digesters is as follows:

$$P = \frac{(IN - OUT)}{IN - (IN \times OUT)} \times 100\%$$

where: IN = % volatile solids in feed sludge

OUT = % volatile solids leaving the digester

P = % reduction in volatile solids

An effective procedure to accomplish a satisfactory percent reduction in volatile solids in an aerobic digester is as follows:

- Waste sludge to one digester and decant that digester each day to attain maximum thickness.
- Turn off the aeration to the digester allowing it settle sufficiently prior to starting the decant cycle. This will normally take 1-2 hours. A sludge judge can be used to determine the depth of sludge/supernatant separation. Insufficient settling will result in high solids concentrations in the supernatant.
- The IN and OUT % volatile solids should be monitored each week and tracked by operation personnel.

- When the digester concentration increases to a point where separation cannot be obtained, the unit has probably reached a 35-40 percent reduction in volatile solids.
- The unit should be isolated and allowed to continue digestion for 2-3 days to ensure stabilization of the most recent feed sludge. After 2-3 days, any additional supernatant should be removed if possible.
- The entire digester should be processed for further disposal either on the drying beds or through the lime stabilization system.
- The unit should be emptied and inspected and waste sludge feed routed to the second digester.
- The third digester should be kept on stand-by at all times to handle solids during emergency and long wet weather periods.
- The lack of digester space should never be allowed to become a limiting factor in sludge wasting from the activated sludge system.

#### **4.1.9 Sludge Drying Beds**

There are a total of seven (7) sludge drying beds. Each of the four large drying beds is 65 feet long and 20 feet wide. The three smaller beds are each 50 feet long and 20 feet wide. All seven beds were in service at the time of the evaluation and there were no apparent problems with the drying beds. Based on information provided by the operators, it takes from 2 to 3 weeks to obtain a dried cake when weather conditions are favorable. Operational personnel indicated that they load the drying beds to a level of 8-12 inches. If all seven drying beds are utilized at a depth of 12 inches, the drying beds will accommodate the contents of one digester.

Digested sludge can be drawn to the drying beds from the digesters by gravity flow depending on the level of sludge in the digester. Alternatively, sludge can be pumped into the drying beds from the digesters by the new digested sludge pump station. If dried sludge is to be land applied, it must meet the requirements of the sludge regulations with regard to Processes to Further Reduce Pathogens (PFRP) (1.4.1.1).

#### **4.1.10 Digested Sludge/Lime Conditioning System**

The upgrade of the WWTP resulted in the installation of a new lime conditioning system for further stabilization of sludge prior to land application. This stabilization

process is part of the new requirements under the Federal Sludge Regulations contained in 40 CFR 503. In addition to digestion, land applied sludge must undergo a PFRP. In order to accomplish this PFRP at the Shaw AFB WWTP the additional equipment has been installed.

The digested sludge pump station pumps sludge from the aerobic digesters into the lime stabilization system. The digested sludge pump station consists of two, 130 gpm peristaltic pumps and associated piping and valving.

The lime stabilization system has two, 25,000 gallon, underground, reaction/stabilization vessels. The sludge and lime are mixed and aerated in these vessels. Two, 160 CFM positive displacement blowers with air supply lines and static tube aerators provide the air. One, 250 gpm lime stabilization sludge pump is used for pumping out the stabilized sludge from the reaction vessels.

The Lime Stabilization Feed System also has one 12 foot diameter by 36 foot high lime storage silo, a 2.5 cubic foot hopper to receive lime from the silo and transfer it to the feed equipment, a 1.5 horsepower vibratory motor and a 100 cubic feet per hour maximum, volumetric feeder.

The system is currently operated so that digested sludge is conditioned with lime to a pH of 12.0 and held in the vessels for a minimum of two hours at that pH. This strategy complies with the land application requirements of the sludge regulations in that it is an approved PFRP. A record keeping system should be developed which thoroughly documents the stabilization and land application process for the WWTP sludge (1.4.1.1).

#### **4.1.11 Land Application System**

Stabilized sludge is hauled by tank truck to the 171-acre land application site. The site is located between the flight line and the east boundary of the base. The site is in a planted pine forest. Rows have been cleared between the trees for the tank truck to pass through the site as the sludge is surface-applied. The WWTP has two options for hauling sludge to the site. The Base owns a 2,000-gallon tank truck which is equipped for surface application of sludge. This truck has not been consistently reliable. Maintenance and repair problems have kept this vehicle out of service approximately 25 percent of the time in recent months. The other option is to use a contractor whom the base has hired under an open-ended, as-needed purchase order. The base is reluctant to use the contractor for other than occasional instances because of the cost. It is very important

that the WWTP have reliable, consistent sludge disposal capability. A high priority response should be established with the vehicle maintenance shop to ensure quick turnaround of repairs on this vehicle. Sludge drying bed space should be available to the greatest extent possible to ensure that there is sludge disposal capability available at the plant, also. A map and record keeping system should be developed for the Land Application System such that sludge disposal quantities on individual plots of land within the system can be tracked.

#### **4.2 DESCRIPTION OF THE PLANT PERFORMANCE**

The evaluation team examined plant monitoring reports for the previous 12 months to evaluate compliance with the NPDES Permit Discharge Limitations. Overall the performance of the WWTP has been marginal during this period. There were a total of 31 instances when the WWTP discharge exceeded permit limitations during the months of March 1993 through February 1994. Figures 4.1 through 4.11 illustrate the monthly average, monthly maximum or monthly minimum discharge values for process parameters graphed with their respective permit limitations. Figure 4.1 illustrates the monthly average flow data plotted against the monthly average permit limit. The flow data is consistent throughout the year with the exception of April and May 1993 when the average flow was 2.49 MGD and 3.51 MGD respectively. The evaluation team was told that these peak flows were associated with Infiltration and Inflow(I/I) caused by rainfall but we were unable to establish a correlation between months with high flows and months with high rainfall amounts. Figure 4.2 illustrates the average monthly flow versus total monthly rainfall during the period. The cause of the extreme flow peaks needs further investigation. If there is a source of flow into the sanitary sewer system of the magnitude to create monthly average values over 2.0 MGD, it needs to be located or permit violations will continue to occur even with the new equalization basin in service. The possibility of flow meter malfunctions should also be investigated. The flow meter calibration should be checked weekly by taking instantaneous head measurements in the effluent Parshall flume and comparing the actual flow against the meter readout at the same instant. Also, the flow meter should be calibrated and serviced by qualified personnel twice per year.

The WWTP exceeded its effluent limitation for average BOD and maximum BOD on a number of occasions during the twelve months. Figure 4.3 illustrates the monthly average discharge versus the monthly average permit limit for BOD. Figure 4.4 show the monthly maximum BOD versus the maximum permit limit. The maximum BOD

Figure 4.1

ES ENGINEERING-SCIENCE

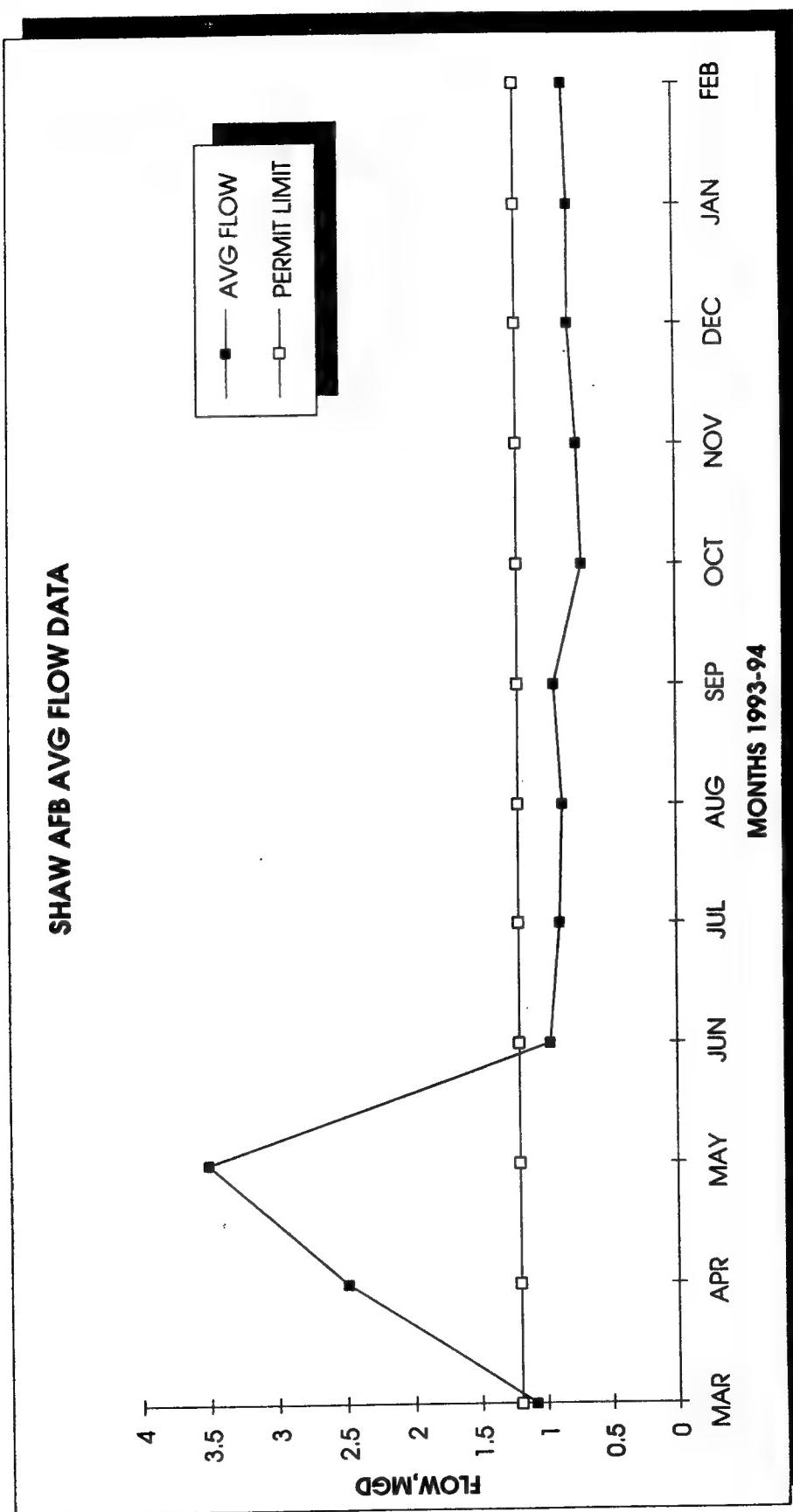


Figure 4.2

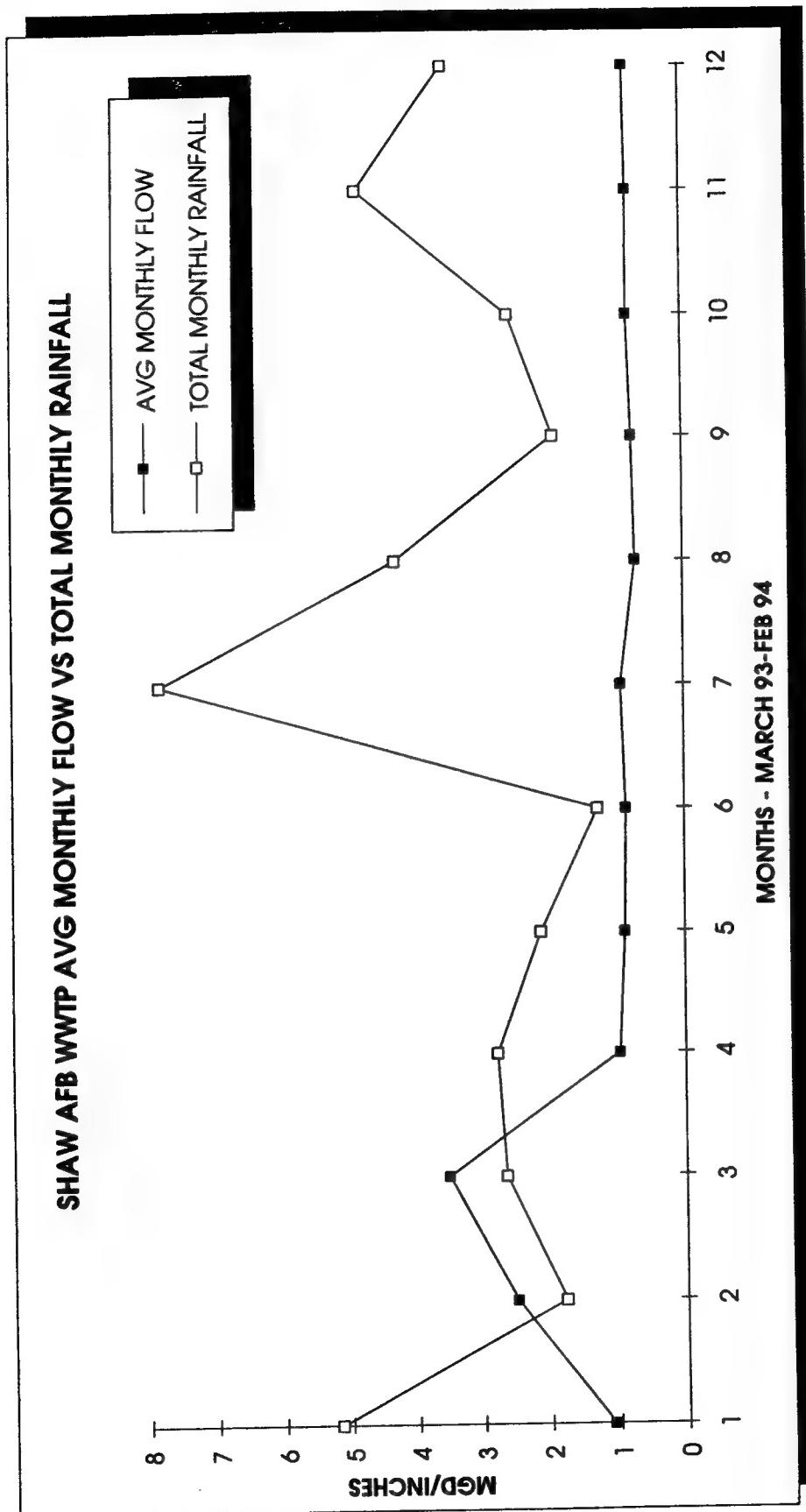


Figure 4.3

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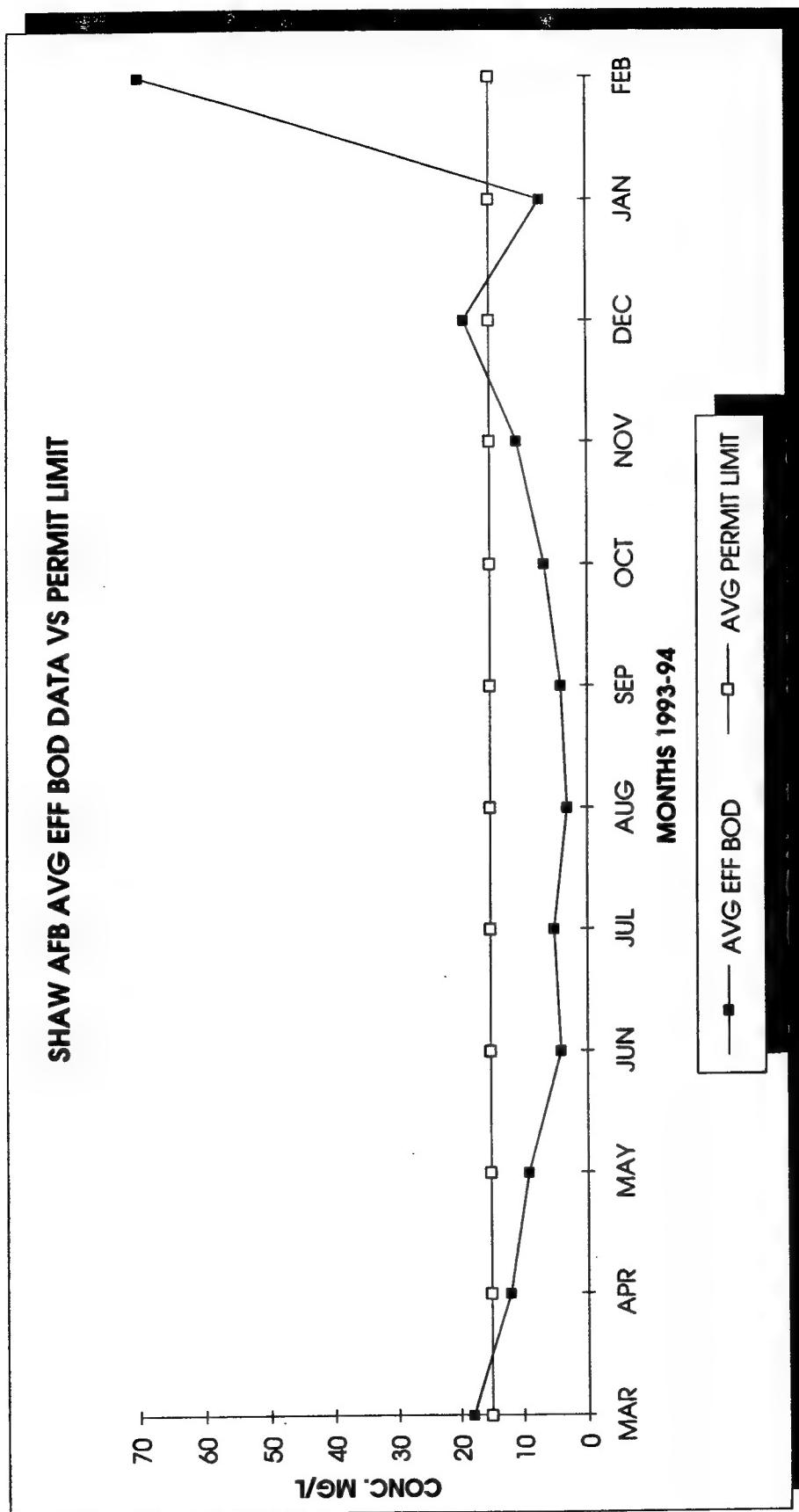
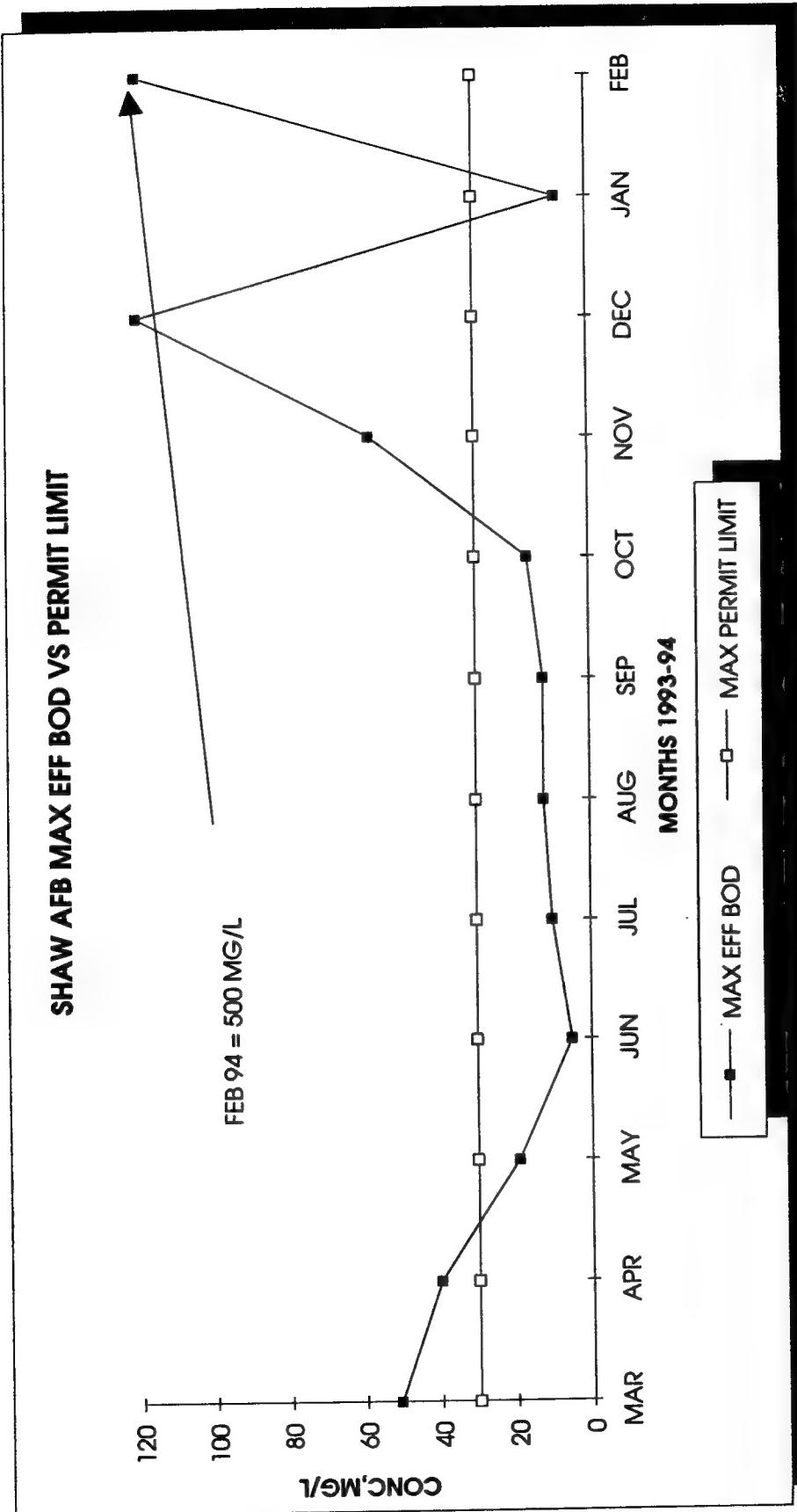


Figure 4.4

ES ENGINEERING-SCIENCE



discharge during this period occurred in February 1994 when the plant had a single day discharge of 500 mg/l. This extreme instance in February 1994 was the result of a severe sludge blanket losses from the secondary clarifiers. The reason for this discharge is not entirely clear and it was not associated with either high flow or excessive solids inventory in the activated sludge system. WWTP personnel have reported that during that time period, the plant experienced problems from industrial waste discharges into the system. It was reported that large amounts of white foam formed in the equalization basin and there was a "chemical smell" at the headworks.

The WWTP exceeded its effluent limitations for average and maximum TSS on a number of occasions during this period as well. The maximum TSS discharge during this period was similar to the instance of maximum BOD discussed above. The single day maximum TSS was 900 mg/l and occurred in February 1994. There were six other instances of violations of the maximum effluent TSS limit. Other than the instance in February 1994, the other problems point out the need for a consistent process control program and regular sludge wasting. Figures 4.5 illustrates the average TSS against the average permit limit. Figure 4.6 shows the maximum TSS discharges during the period plotted against the maximum TSS permit limitation.

The Shaw AFB WWTP maintained permit limitation compliance for ammonia-nitrogen and DO during the period under discussion. Refer to Figures 4.7 and 4.8 for illustrations of maximum ammonia nitrogen plotted against its permit limit and DO graphed with its minimum permit limitation.

The Shaw AFB discharge exceeded its permit limitation for maximum TRC eight out of twelve months during the period. Two changes were occurring during this period which should alleviate this problem. First the new dechlorination system was completed as part of the plant upgrade. The addition of sulfur dioxide as a dechlorinating agent has given the plant the capability of removing the excess residual chlorine. In January 1994, the WWTP personnel began sampling for TRC at the plant outfall instead of at the plant effluent. This has improved the situation with TRC limitation compliance due to the increased mixing and reaction time for the sulfur dioxide and residual chlorine. Figure 4.9 illustrates the TRC versus the TRC permit limit during the time under consideration.

The discharge of Fecal Coliform Bacteria exceeded the maximum allowable number under the permit on seven occasions during the 12 months from March 1993 through February 1994 even though there were no violations of the monthly average limitation.

Figure 4.5

ES ENGINEERING-SCIENCE

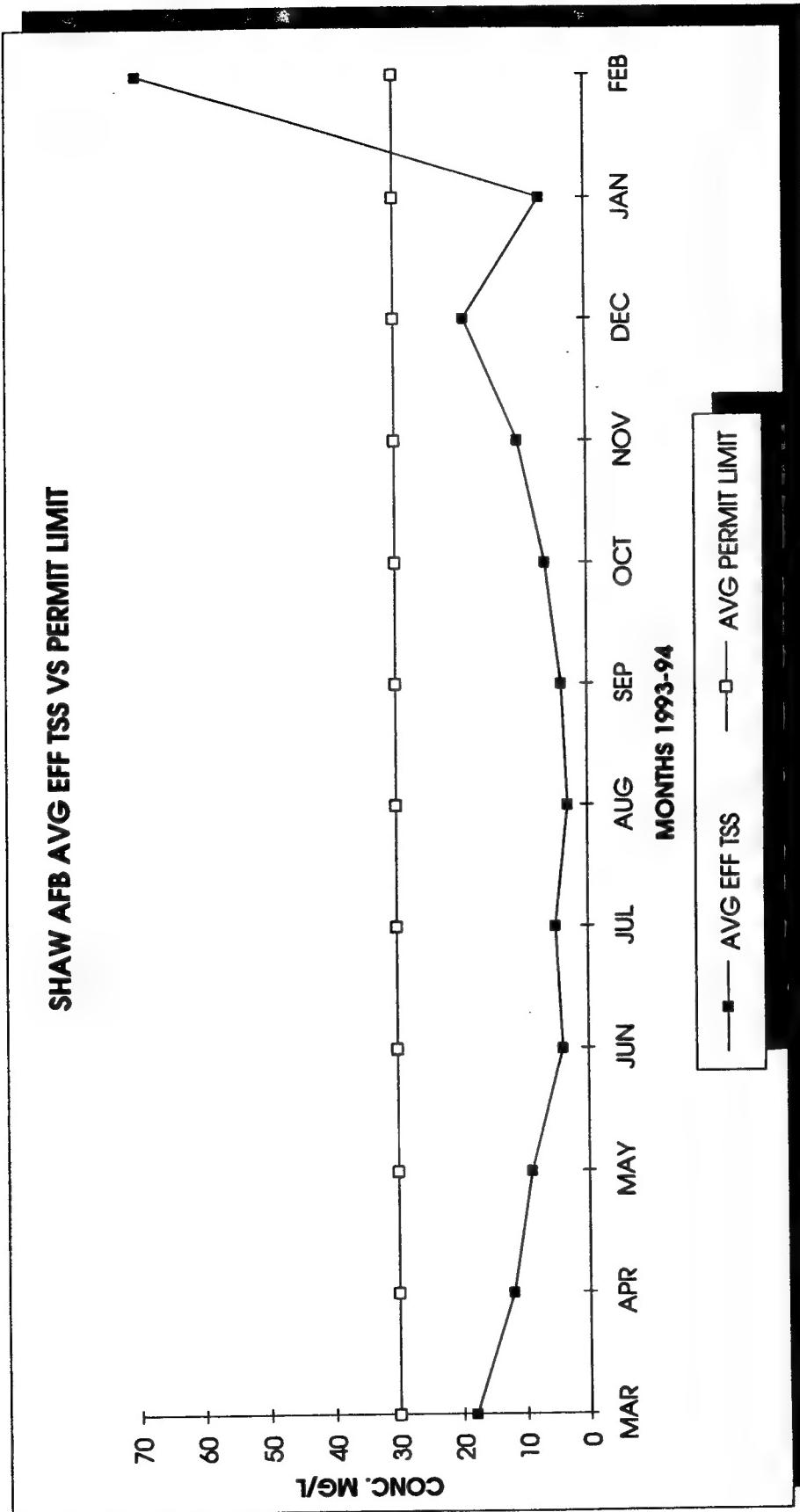
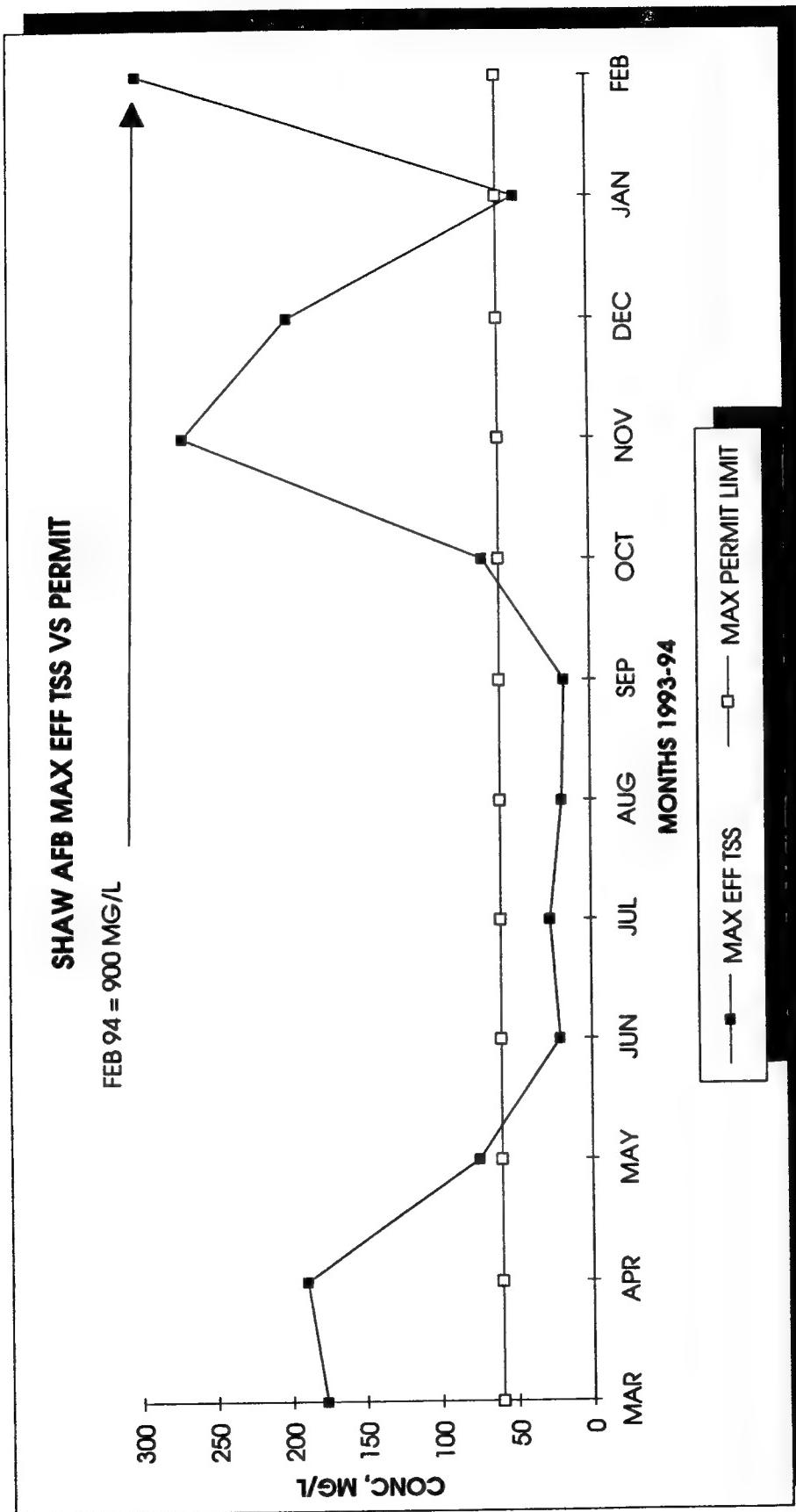


Figure 4.6

ES ENGINEERING-SCIENCE



M:\HEWITT\SHAW\MAX EFF TSS DATA 1993-94

Figure 4.7

ES ENGINEERING-SCIENCE

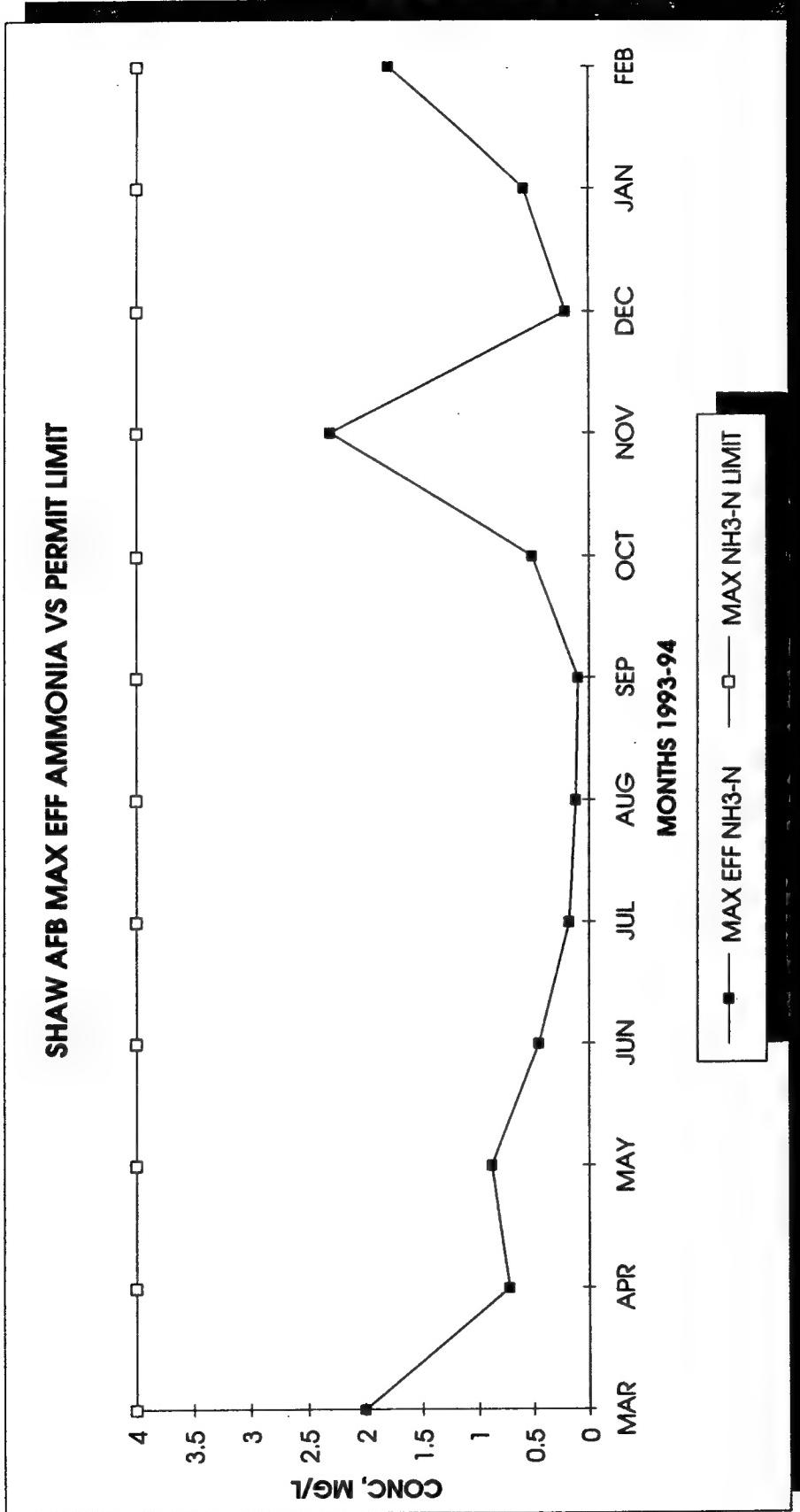
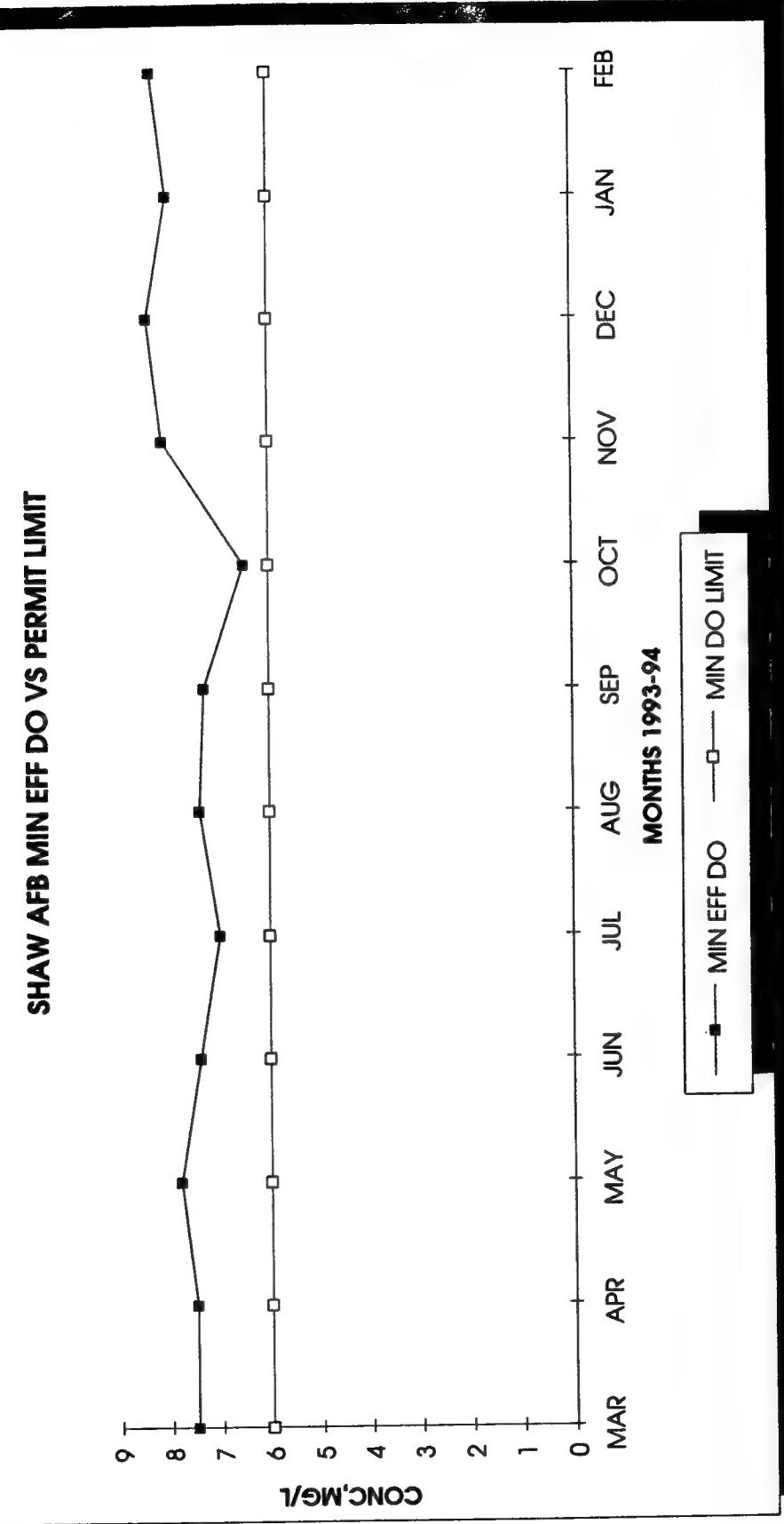


Figure 4.8

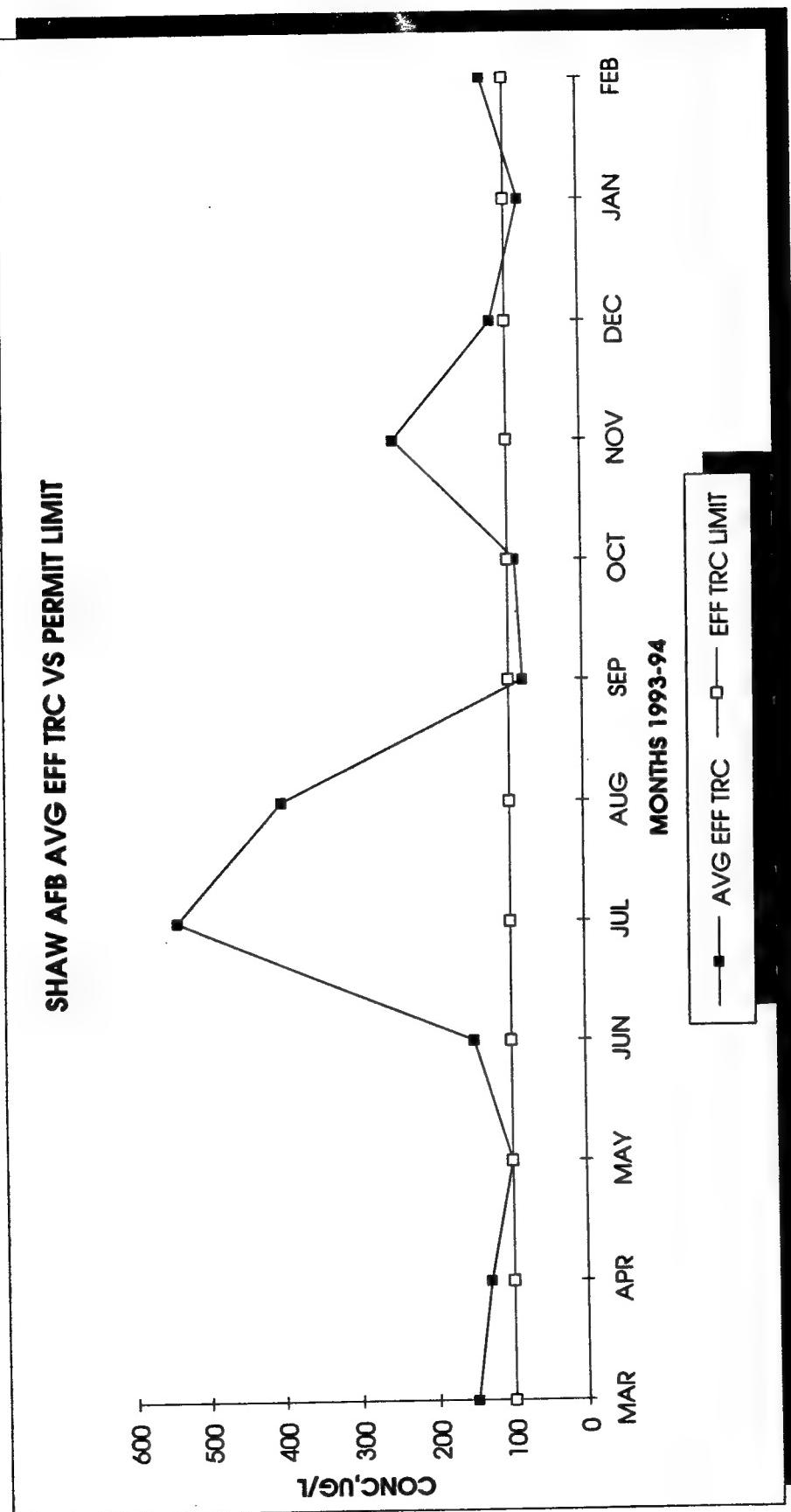
ES ENGINEERING-SCIENCE



M:\HEWITT\SHAW\MIN EFF DO DATA 1993-94

Figure 4.9

ES ENGINEERING-SCIENCE



There is a strong likelihood that these violations will decrease significantly once the suspended solids levels are reduced in the effluent. Even with a consistent dosage of chlorine and adequate chlorine residuals, Fecal Coliform Bacteria are often resistant to disinfection if they are insulated within large concentrations of suspended solids. Refer to Figures 4.10 and 4.11 for illustrations of the average and maximum Fecal Coliform Bacteria discharges versus their respective permit limitations.

#### **4.3 NON-DOMESTIC DISCHARGES**

Based on discussions with plant personnel and flight line maintenance shop personnel, five potential non-domestic wastewater sources were identified at the Base which could have an impact on the WWTP if discharges from these areas reached the sanitary sewer system. Each of these sources was visited with a representative of the WWTP staff to ascertain if waste handling practices presented potential problems. A brief description of the operations and the wastewater generated at each facility is presented below.

The Photo Shop creates X-Ray images of aircraft parts to detect metal stress. The development of film images takes place at another location. Liquid waste generating activities at the Photo Shop are all associated with the penetrant line. Three processes are undertaken. Aircraft parts are immersed in penetrant solution and rinsed, the parts are then cleaned with an emulsifier and finally they are placed in a developer bath. Rinse water from this operation flows to the sanitary sewer. When the 500 gallon tanks of penetrant, emulsifier and developer are spent they are hauled off-site by a contract waste hauler. This area represents a potential threat to the WWTP. The rinse water is very low in volume and is probably inconsequential but if the baths were to be released to the sewer, the plant would be severely affected. The penetrant is a hydrocarbon base green liquid that would have a strong odor of fuel or oil. The emulsifier is an ethylene glycol product that is a dark pink and has a tendency to foam. Its purpose is to clean excess penetrant from the aircraft parts. It is not known what the effects of this solution would have at the WWTP if discharged. The developer is a sodium chromate, clear yellow solution that if discharged in a large quantity would have a serious toxic effect on the WWTP. It is mixed at a ratio of one pound per gallon. There was no indication that the baths had been discharged to the sewer system from this shop. This shop should be more closely monitored, however. Records should be examined to ensure waste handling practices are being conducted properly.

Figure 4.10

ES ENGINEERING-SCIENCE

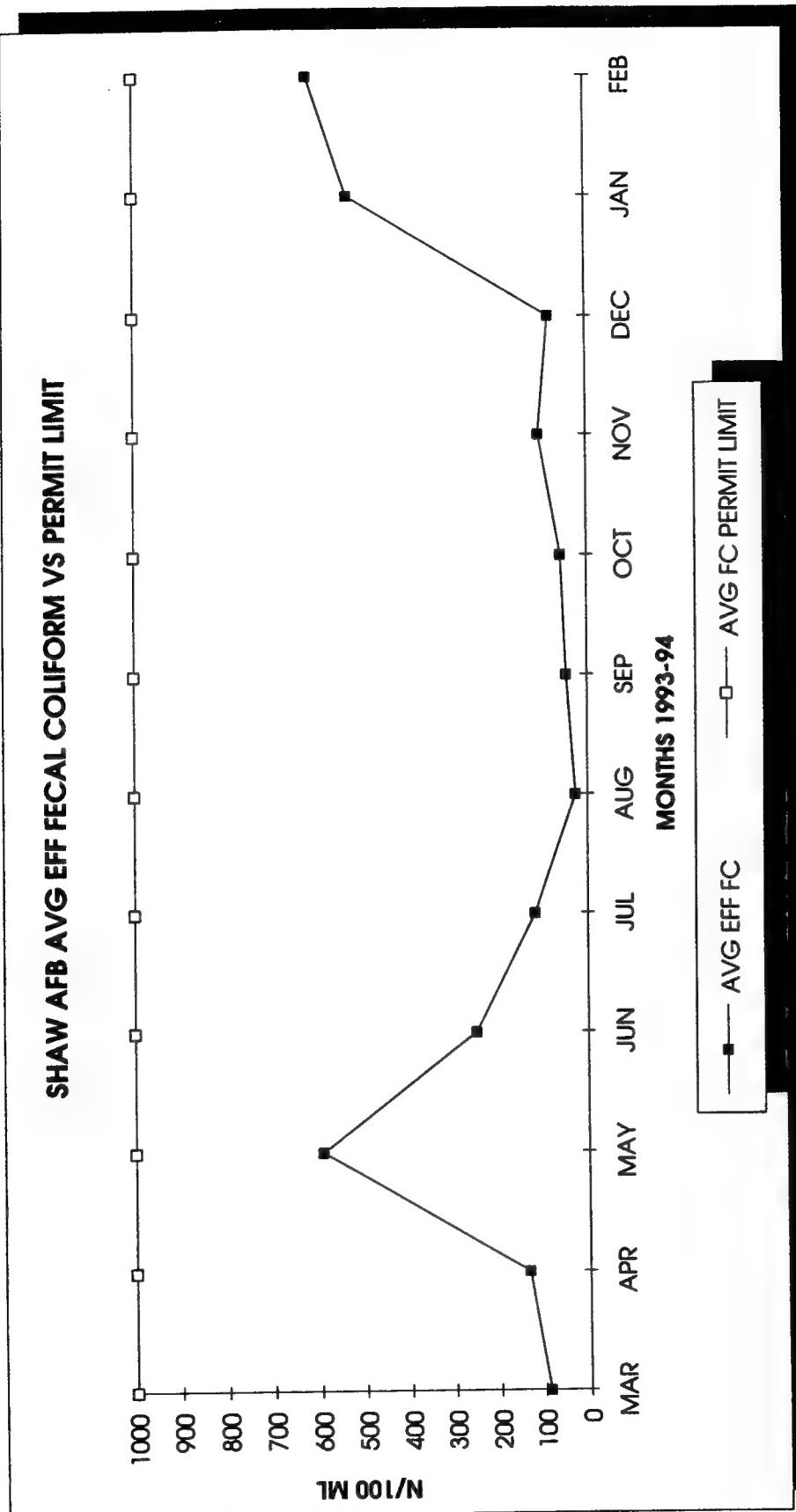
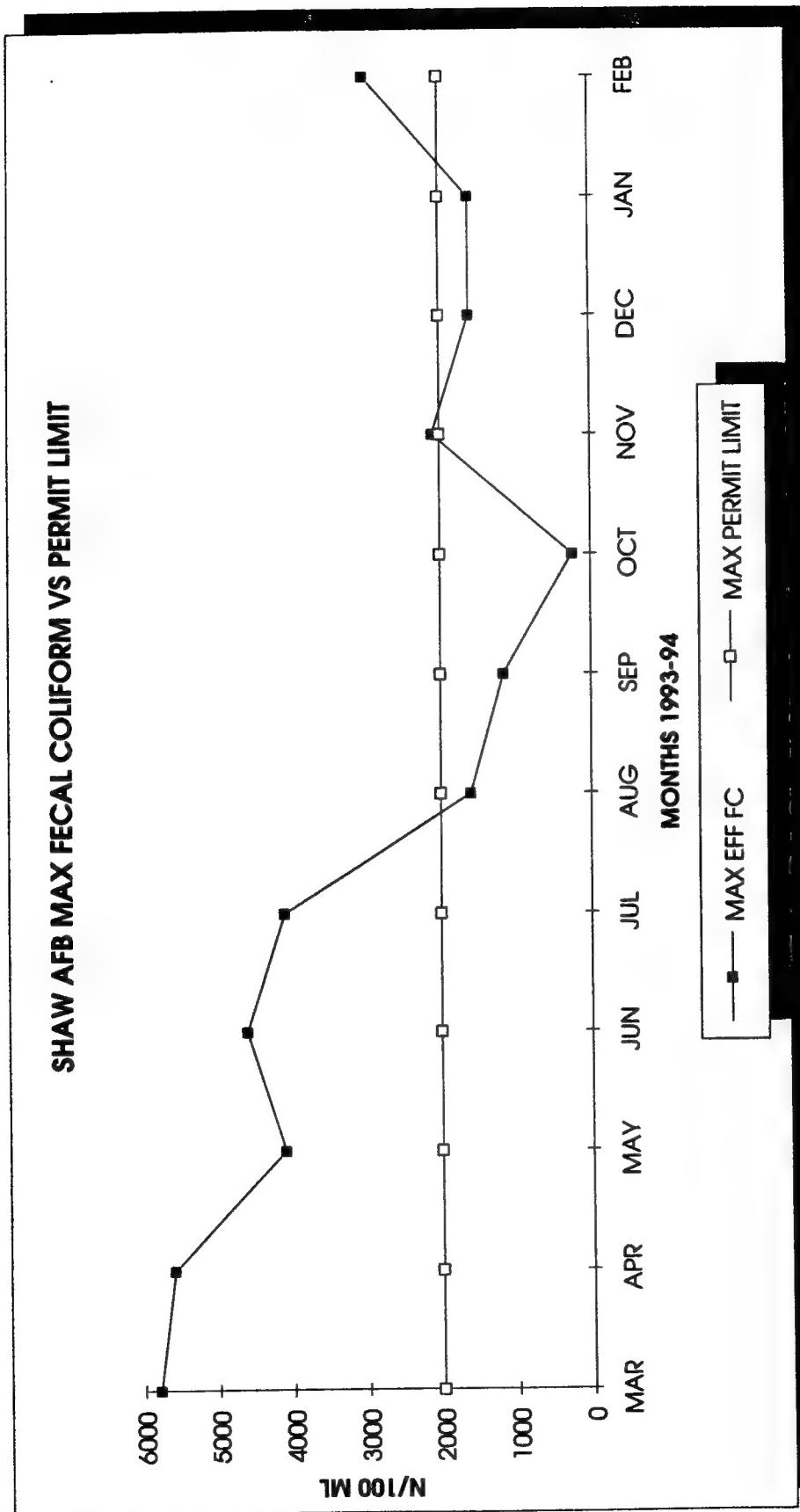


Figure 4.11

ES ENGINEERING-SCIENCE



The Fuel Tank Maintenance Area was visited due to the potential for fuel from this area reaching the sanitary sewer system. As its name implies, this shop inspects and repairs fuel tanks. Fuel is emptied from the tanks and any spilled fuel that is not contained is discharged to an oil/water separator. The oil/water separator is equipped with a pump that pumps oil accumulated in the separator to a storage tank. The pump is controlled by an interface probe, or float, which detects liquid level in the separator.

The Aerospace Ground Equipment(AGE) Maintenance shop was visited because of the potential for oily wastes associated with equipment maintenance to reach the sanitary sewer system. After observation and discussions with shop personnel, it did not appear that this shop presents a high potential hazard to the WWTP. All waste oil is placed into a waste oil holding tank which is serviced by a contractor monthly. Spills in the AGE maintenance area and wastewater from the AGE washrack flow to an oil/water separator.

The Electro/Environmental shop which services both lead acid and Nickel-Cadmium (NiCd) batteries was visited because of its potential to discharge wastewaters with high metals content and extremes in pH. The Lead-Acid battery shop performs small neutralizations and occasionally has wash water clean up and disposal. The operation does not appear to present a high potential impact for the WWTP. Broken batteries which are brought in for service are taken to DMRO for disposal off-site by a hazardous waste contractor. The NiCd battery shop is less of a potential problem to the WWTP than the Lead-Acid shop. The NiCd batteries are sealed and open cells occur rarely and when that does occur, they are disposed of by DMRO.

The Corrosion Control Shop was visited but it was determined that this is a dry operation at present. The usual chemical stripping of aircraft parts that takes place in corrosion control has been replaced by a glass bead blasting operation. There are no drains within the stripping and painting areas. There is a contained storage area outside the shop where solvents are stored. The shop maintains a spill kit in the event of a solvent spill. It did not appear that the corrosion control area represents a significant potential problem for the WWTP.

Although there appears to be a small potential for industrial waste entering the sanitary sewer system, no definitive conclusions were reached with regard to impact by industrial wastewater on the WWTP. Plant personnel have indicated that discharges from on-base have created problems with WWTP operation in the past. A case in point is the plant upset that occurred in February 1994. Plant personnel indicated that an

unknown substance entered the plant which had a chemical odor and created three feet of foam in the equalization basin. Investigations into the source of this discharge were not successful. It appears that a more thorough, systematic industrial survey should be performed on the base to ensure that all sources of industrial waste and waste handling practices are identified. From this type of information a contingency plan for identifying and responding to industrial wastewater problems at the WWTP can be developed.(1.4.1.7)

#### **4.4 SUMMARY OF OPERATIONAL PROBLEMS IDENTIFIED**

During the Phase I visit, the evaluation team identified a number of operational problems which have been discussed in Section 4 of this report. The following is a summary of the problems discussed in this section along with recommended improvements.

- The installation of a remote monitoring system for all base lift stations should be evaluated by the Civil Engineering Squadron. At present, all lift stations are monitored manually once per shift. Remote monitoring would reduce the personnel hours spent on making rounds to inspect each station three times per day. Site visit time could be reduced by at least two thirds. Some stations would need only to be visited when preventive maintenance is due.
- The influent grit removal system should be taken through the troubleshooting procedure discussed in this section to determine the reasons for the absence of grit being processed by the new equipment.
- Vendor training on the new screw lift pumps' variable speed drives needs to be obtained for plant personnel. Additionally, once training on this equipment is obtained, a strategy for operating the pumps in conjunction with the equalization basin should be developed.
- A properly sized lime feed system for the influent needs to be installed to ensure that adequate alkalinity is available for nitrification in the activated sludge system without depressing the pH to dangerously low levels.
- As discussed extensively in this section of the report, a process control strategy should be developed for the activated sludge system based on maintaining a constant SRT. Sludge should be wasted daily under this scheme and increased process control testing is required.

- A flow meter should be installed in the waste activated sludge line to obtain accurate readings of the amount of sludge wasted and to be able to more effectively control the wasting process.
- The plant effluent flow meter calibration should be checked weekly against instantaneous head measurements in the Parshall flume. The meter should be serviced/calibrated twice per year by qualified instrumentation personnel.
- A new DO meter with a 50 foot probe is needed to monitor the aeration basins properly for DO. DO measurements of each basin should be taken once per shift in each basin. In addition, DO profiles of each basin should be made at least quarterly.
- Sludge blanket measurements should be taken on each shift and recorded. Return sludge rates should adjusted to ensure that blanket levels are kept at a minimum.
- The tertiary filters' media needs to be replaced as soon as possible to ensure that the filters have adequate capacity to treat the plant flow and to ensure that they can be adequately cleaned during backwashing.
- The filter surface sweeps should be replaced so that the top of the media surface can be properly cleaned during the backwash cycle.
- Records of critical operating data on the filters needs to be maintained so that a logical and effective operating strategy can be developed. These records are discussed in this section. In addition, process performance data is needed on a daily basis(i.e. filter influent and filter effluent TSS).
- The filter media should be inspected at least twice per year to make sure it is still in good operating condition and that excessive media loss is not occurring.
- Piping modifications are needed to allow the WWTP to use the new chlorine contact chamber during normal operations.
- New operating procedures are needed for the aerobic digesters. The digesters should be operated based on percent reduction in volatile matter. This strategy is outlined in this section as are procedures for feeding, decanting thickening and processing the digester sludge for optimum use of the digester capacity.
- A high priority must be placed on keeping the sludge truck in operation on a more consistent basis. If the truck continues to experience long periods of

down-time, sludge should be hauled to the land site by the contractor. It is imperative that sludge disposal keep pace with plant process demand. Disposal problems should not be allowed to limit process control of the activated sludge system.

- A comprehensive survey of the base industrial shops should be undertaken and a contingency plan established for responding to industrial discharges to the sanitary sewer system.

## **SECTION 5**

### **PLANT MAINTENANCE**

#### **5.1 CONDITION OF EQUIPMENT AND HOUSEKEEPING**

At the time of the Phase I evaluation, maintenance and housekeeping in all of the pump stations was excellent. Maintenance and housekeeping at the WWTP needed improvement in the following areas:

- The variable speed drives for the influent pump station were not functional. There seems to be some confusion as to whether these instruments were hooked up and were capable of controlling the speed of the lift pumps. Plant personnel were advised to contact the vendor to supply needed training on these instruments. The present system of manual flow control using the influent gates is cumbersome and time consuming, especially during times of heavy rains. Using these variable speed controllers would be more efficient.
- The skimmers on the secondary clarifiers are in need of repairs. Work orders were written on this item during the Phase I plant evaluation.
- The weirs on the secondary clarifiers need to be checked for level and adjusted if necessary. Visual observation of these weirs indicate possible problems.
- The surface washers in the tertiary filters have been out of operation for an extended period of time. The WWTP maintenance mechanic indicated that repairs would be initiated on these items once a work order is issued.
- Housekeeping in the digester blower room needs improvement. This problem is caused by the doors remaining open at all times. The doors to this room are in need of immediate repair.
- More attention needs to be paid to painting and corrosion control in the clarifier area.
- Operators have indicated that the condition of the media in the tertiary filters is poor. This accounts for the reason that filters have to be backwashed often. The media should be changed as soon as possible.

- Design changes have been made to the instrumentation controlling the filters but these changes were not documented. Drawings should be made to indicate the circuits that exist at present to facilitate future operation and/or repairs.
- Breakdown of the sludge hauling truck is a common occurrence. As this is a critical piece of equipment more priority should be given to the maintenance on this vehicle.

Overall, the general condition of equipment and housekeeping was good.

## **5.2 PLANT MAINTENANCE PROGRAM**

A maintenance management system called the Recurring Work Program (RWP) is established and implemented for the WWTP and pump stations. This is a base-wide program and includes both breakdown maintenance as well as preventive maintenance (PM).

A computer report of equipment requiring maintenance is produced weekly. This report called Recurring Work Program Report (RWPR) which is a listing of equipment items requiring maintenance that week. Each item has an equipment number. The RWPR draws from the master preventive maintenance schedule for items requiring maintenance on a particular week. The RWPR gives a description of the required work, the estimated hours to complete the task and spaces for information once the work is completed which are used to update the maintenance database. See Figure 5.1 for an example of the RWPR.

This list is generated from a master PM file. A Maintenance Action Sheet (MAS) can be called up and printed which lists the name of the particular piece of equipment requiring PM, the cost center, the task number, its frequency, hours needed to perform the PM, crew size, special equipment needs, plus a full description of the work that needs to be done (Figure 5.2). The mechanic that performs the PM notes the actual work that is done on the MAS. This data is entered into the computer which clears this item from the maintenance list.

Breakdown items are listed on Maintenance Referral Action form (Figure 5.3). This form serves as a work order and lists the problems that exist. This breakdown item is entered into the computer. The item remains on the maintenance list until repairs are made and the repair items are entered into the computer.

Date 07/27/93 Recurring work program Report  
Page 68 till work scheduling for the week ending 930801  
Gas Shop 469

frequency	Equip	Line No.	Description of work	Address	Entire	Actual	Crit	Crsz	Min	Max	Std	Stand	Facility	Schedule
Monthly	Equipment	6 036001	CHECK LIFT STATION		1.0				1		01	Scheduled	930801	930712
Monthly	Equipment	4 00208	CHECK LIFT STATION	LIFT STATION	1.0				N		01	Scheduled	930801	930712
Monthly	Equipment	4 03040	CHECK SWIMMING POOL		2.0				N		01	Scheduled	930801	930712
Monthly	Equipment	1 00049	CHECK LIFT STATION	LIFT STATION 49	0.0	11			N		01	Scheduled	930801	930712
Monthly	Equipment	4 0225	CHECK LIFT STATION	LIFT STATION 225	0.0	6			N		01	Scheduled	930801	930712
Monthly	Equipment	4 00608	CHECK LIFT STATION	LIFT STATION 608	0.0	4			N		01	Scheduled	930801	930701
Monthly	Equipment	4 00609	CHECK LIFT STATION	LIFT STATION 609	0.0	3			N		01	Scheduled	930801	930701
Annual	Equipment	7 492	CLEAN WATER TANKS		1.0	17			N		01	Working	930709	930713
Monthly	Equipment	2 00692	692-693		1.0	17			N		01	Scheduled	930801	930712
Monthly	Equipment	3 00718	CHECK LIFT STATION	LIFT STATION 718	0.0	5			N		01	Scheduled	930801	930715
Monthly	Equipment	4 10849	CHECK SWIMMING POOL		0.0	12			N		01	Scheduled	930801	930701
Monthly	Equipment	5 888	CHECK RECIRCULATING PUMP		2.0				N		01	Scheduled	930801	930715
Monthly	Equipment	2 00889	WATERWASTE PLANT		0.0	9			N		01	Scheduled	930801	930715
Monthly	Equipment	5 895	CHECK INFLUENT PUMP STATION		0.0	6			N		01	Scheduled	930801	930715
Monthly	Equipment	2 01863	WATERWASTE PLANT		0.0	6			N		01	Scheduled	930801	930712
Monthly	Equipment	4 369	CHECK LIFT STATION	LIFT STATION 949	1.0	4			N		01	Scheduled	930801	930712

Total Estimated Hours for this Shop - 15.5  
Total Actual Hours for this Shop - 1.5  
Number of RRP Records for this Shop - 12  
This report was sorted by - Shop, Facility, Equip Type

Facility, Equip Type

Figure 5.2

**ES** ENGINEERING-SCIENCEMAS Task Detail Screen

Cost Center: VLSBA 469

MAS No: 6 Title: VAR SP POSITROL

Task No Freq Description

001 L LOAD OIL &amp; TOOLS ON TRUCK

INFORM OPERATOR SYSTEM WILL BE DOWN

OBSERVE THE OPERATION OF THE EQUIPMENT AND THE PHYSICAL CONDITION OF THE OIL

LOCKOUT THE ELECTRICAL SYSTEM

CHANGE OIL AND CHECK THE OLD OIL FOR CONTAMINATION

REMOVE LOCKOUT AND CHECK OPERATION OF THE PUMP UNIT

CLEAN MAINT AREA AND INFORM OPERATOR SYSTEM IS BACK ON LINE

RECORD INFORMATION IN FACILITY RECORD

Work Sequence Number: 1

Hours to perform Task: 2.400

Crew Size: 2

Number of Occurrences: 1

Heavy Equip Required? N

Total Task Hours: 2.400 (Hours X Occurrences)

EPS Standard Used? N

---

(1)Keys (2)List Hrs by Freq (4)Prev (5)Next (6)PMI Book (7)EPS Book  
(9)Modify (11)Add Task (12)Delete (15)Print (16)Return (32)Exit

## MAINT. REFERRAL ACTION

FACILITY 2233\_\_\_\_\_

DATE \_940429\_\_\_\_\_

TIME \_\_\_\_\_

DISCREPENCY OR MALFUNCTION CHEMICAL FEEDER WILL NOT PUMP. SOME INTERNAL  
PARTS MISSING\_\_\_\_\_ACTION TAKEN BY OPERATOR REPAIRED CHEMICAL FEEDER AND REPLACED MISSING  
PARTS  
PARTS. INFORMED OPERATOR SYSTEM BACK ON LINE\_\_\_\_\_CABELLO\_\_\_\_\_  
OPERATOR SIGNATURE

A computerized list of spare parts is available which indicates the part name, bin number where the part is located, the part number and the quantity on hand (Figure 5.4). The quantity on hand is updated quarterly by manually checking the inventory in the store room. Needed parts are then put on order.

The plant equipment manufacturers list is fairly complete and manuals are readily available. Manuals are kept in the office for use by the maintenance mechanic. During the Phase I visit, critical manuals were shipped to the Engineering-Science Atlanta office for the purpose of preparing maintenance schedules for the O&M manual.

A complete set of drawings for the treatment system are available at the plant site. A copy was made available to the evaluation team and will provide needed information to develop standard operating procedures for the O&M manual.

REPORT DATE / /		WATER AND WASTE INVENTORY BY BIN NUMBER			
BIN NUMBER	CSL NUMBER	PART NUMBER	QUANTITY ON HAND	UNIT OF ISSUE	DESCRIPTION
A 146		P 29266	000000		PLASTIC BUSHING
A 147		P 29624	000000		GASKET SUCTION SEAT
A 149		P 35606	000000		GASKET
A 150		P 35607	000000		BUSHING
A 151		P 37964	000000		PINION SHAFT
A 152		PXA 39234	000000		COUPLING NUT
A 154		P 39664	000000		STUD
A 155	A955D	P 39757	000000		MACH SCREW ( FIL HD NYLON)
A 156		PXA 40419	000000		POPPET VALVE
A 157		RK 445006	000000		RUBBER EXTRUSION
A 158		P 44848	000000		DIAPHRAGM SPACER
A 159	A416A	P 44849	000000		PUMP BODY
A 160	A415W	P 44850	000000		SUCTION VALVE SEAT
A 161		P 45771	000000		SOLUTION TUBE
A 162		P 45772	000000		POPPET STOP (RETAINER)
A 163		P 45773	000000		GASKET
A 164		P 47175	000000		DISCHARGE ELBOW
A 165		P 51561	000000		BUSHING
A 166		PXC 52821	000000		DAIL A588
A 167		P 53620	000000		CAP
A 168		P 54479	000000		DRAIN NIPPLE
A 169		P 54680	000000		SCREW (RD HD BRASS) 3/8-16
A 170		RP 684464	000000		PLASTIC TUBING
A 171		RP 704451	000000		DRAIN TUBING 5/32X9/32
A 172	B204Z	RP 704818	000019	FT	PLASTIC TUBING 1/4X3/8
AB 018U	A 177	VPXA 3200	000000		VALVE WASHER
B 001		0008	000000		NUT
B 002		L 01965	000000		WARNING LABEL
B 003		L 02556	000000		CAUTION LABEL
B 004		P 16544	000000		BOLT (HEX. HD., MONE L)
B 005		P 18102	000000		LOCKWASHER, 1/4 (MO NEL)
B 006		P 19386	000000		YOKE SCREW
B 007		U 23016	000000		YOKE ASSY
B 008	B235R	U 25890	000005	EA	RETAINER GUIDE
B 009		U 26303	000000		LOCKING CAP SCREW
B 010		U 26436	000000		CAP
B 011/203K	B248J	PXA 26482	000009	EA	O-RING (VITON) 3/8 X 1/2 DD
B 012	B204N	PXB 39234	000014	EA	UNION NUT 3/8 TUBING
B 013	B2040	P 39235	000011	EA	90 HALF UNION ELBOW
B 014	B248F	P 48328	000000		ADAPTER
B 015	B235D	P 48329	000011	EA	STEM SPRING
B 016	B236J	P 48330	000000		SPRING
B 017	B236K	P 49021	000000		OUTER DIAPHRAGM
B 018		P 49022	000000		INNER DIAPHRAGM
B 019		PXB 50222	000000		UPPER BODY
B 020		P 50223	000000		SPRING ADJUSTER
B 021	B248H	P 50225	000000		SPPOOL
B 022	B236I	P 50344	000000		KNOB
B 023		P 50557	000000		LEAD GASKET
B 024	B235T	PXB 50559	000001	EA	LOWER BODY

## **SECTION 6**

### **LABORATORY AND SAMPLING PROGRAM**

#### **6.1 SAMPLING SCHEDULE**

Table 6.1 presents the current sampling and analysis schedule for the Shaw AFB WWTP. The schedule includes samples taken for effluent compliance and for plant process control. The schedule provides a frequency of sampling and analysis for each parameter, as well as where the individual parameter is analyzed. Currently, some of the analytical results submitted to South Carolina Department of Health and Environmental Control (DHEC) for NPDES monthly reporting purposes are produced at an outside contract laboratory. The WWTP laboratory analyzes samples for Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Dissolved Oxygen (D.O.), Total Chlorine Residual (TRC) and pH. The WWTP lab is certified to run these analyses by DHEC. There is a unnecessary duplication of effort and resources in the view of the evaluation team with regard to sample analyses for BOD and TSS. (1.4.1.5).

#### **6.2 LABORATORY PROCEDURES**

During the Phase I site visit, the ES evaluation team undertook an evaluation of the laboratory procedures which are performed at the Shaw WWTP laboratory to ensure that self-monitoring data generated is produced in accordance with approved procedures. The lab technician uses a set of step-by-step procedures for analysis of BOD, TSS, and D.O., TRC and pH. These procedures are very thorough and are part of the WWTP laboratory program which is certified by DHEC. The lab technician is performing lab analyses in accordance with the lab's written procedures. Minor comments on the procedures are provided in the following sections. The WWTP is not currently analyzing samples for three permit required parameters. Ammonia-nitrogen, Fecal Coliform Bacteria and Total Phenols are analyzed by an outside laboratory for reporting purposes. These analyses were not evaluated during Phase I. It was our understanding that the WWTP plans to eventually get certification for ammonia and Fecal Coliform. Therefore, a set of procedures will be included in the O&M manual for these parameters. (1.4.1.5).

**TABLE 6.1**  
**SHAW AFB WASTEWATER TREATMENT PLANT**  
**SAMPLING/ANALYTICAL SCHEDULE**

Parameter	Frequency	Laboratory	Permit Requirement
Influent BOD	2/week	WWTP	
Final Effluent BOD	2/week	WWTP and Contract	Yes
Influent TSS	2/week	WWTP	
Aeration Basin MLSS	2/week	WWTP	
Aeration Basin MLVSS	2/week	WWTP	
Secondary Clarifier TSS	5/week	WWTP	
Final Effluent TSS	2/week	WWTP and Contract	Yes
Aeration Basins Settleable Solids	4/week	WWTP	
Outfall Dissolved Oxygen (D.O.)	2/week	WWTP	Yes
Aeration Basin D.O.	4/week	WWTP	
Influent pH	Daily	WWTP	
Effluent pH	Daily	WWTP	Yes
Outfall pH	2/week	WWTP	
Influent Temperature	Daily	WWTP	
Outfall Temperature	2/week	WWTP	
Effluent Chlorine Residual	Daily	WWTP	
Outfall Chlorine Residual	2/week	WWTP	Yes
Effluent Ammonia-Nitrogen	2/week	Contract	Yes
Total Phenols	1/Quarter	Contract	Yes
Digester Total Solids	1/week	WWTP	
Digester Volatile Solids	1/week	WWTP	
Effluent Fecal Coliform Bacteria	2/week	Contract	Yes

### **6.2.1 Sampling Procedures**

The Shaw AFB WWTP utilizes automatic composite sampling of the influent and effluent for BOD, TSS and ammonia. Samples are collected automatically and manually composited according to flow. Discrete samples are collected every hour for 24 hours. Hourly instantaneous flow measurement readings are used to determine the volume of sample for compositing. Sample collection and sample reservoir containers are plastic. The composite samplers have refrigerated compartments to preserve samples during the collection period. The influent and effluent sample locations are representative of the wastewater being treated. The effluent sample is being collected after the point of chlorination and dechlorination. Effluent grab samples for pH and D.O. are collected at the plant effluent. Samples for TRC are collected at the plant outfall.(1.4.1.5)

### **6.2.2 Biochemical Oxygen Demand (BOD) (1.4.1.5)**

The following minor procedural items were observed during the laboratory analyses for BOD which should be addressed. These items are not considered deficiencies in that this procedure is certified by DHEC but rather items which will optimize the procedure. The overall procedure and performance of the analysis were excellent.

1. Sample dilutions are currently being measured using a 250 ml. graduated cylinder. Accuracy of the measurements can be improved by using smaller graduated cylinders or pipets.
2. As is common in many wastewater laboratories, the D.O. depletion in the dilution water blank occasionally exceeds the 0.2 mg/l depletion allowed by the test procedure. The most common reason associated with the problem is insufficient cleaning of glassware, bottles and tubing. All BOD glassware, etc. should be cleaned periodically with chromic acid cleaning solution and thoroughly rinsed prior to usage.
3. Bench sheet data and records kept for the BOD test were excellent and meet all test and permit requirements. A common practice which provides clarity to lab records is to have the latest approved procedure pre-printed on the top of the bench sheet and test procedure.

### **6.2.3 Total Suspended Solids (TSS) (1.4.1.5)**

During the analysis of TSS, the following items were observed which should be addressed to ensure that all parts of the procedure adhere to the test protocols.

1. At the time of the evaluations, the analytical balance was not housed on a suitable bench. The balance should be housed on a marble top structure to ensure the instrument's stability. It is our understanding that a new balance and bench for the balance has been ordered.
2. References to the approved procedure should be updated to the latest approved edition of Standard Methods (18th edition).

#### **6.2.4 pH (1.4.1.5)**

A review of the test procedure for pH and observation of the analysis of pH on plant samples indicated that all requirements for analysis, record keeping and meter calibration were being adhered to.

#### **6.2.5 Dissolved Oxygen (D.O.) (1.4.1.5)**

A review of the test procedure for D.O. and observation of the analysis of D.O. on plant samples indicated that all requirements for analysis, record keeping and meter calibration were being adhered to.

#### **6.2.6 Total Chlorine Residual (TRC) (1.4.1.5)**

Due to timing problems during the Phase I evaluation, this test procedure was not observed. Written test procedures are in accordance with requirements. This test procedure will be observed during Phase II and any necessary recommendations will be forthcoming.

### **6.3 ADDITIONAL ANALYSES AND CERTIFICATIONS**

During the Phase I Evaluation, the need for additional analyses, lab certifications and changes in the current use of the WWTP Laboratory were observed.

#### **6.3.1 Permitted Parameters**

Currently, the WWTP is utilizing an outside contract laboratory for analyzing permit required samples for BOD, TSS, Ammonia-Nitrogen and Fecal Coliform Bacteria. The WWTP laboratory is certified to run BOD and TSS analyses and is currently running them. As mentioned in the beginning of this section, this appears to be a duplication of effort and resources. It is our recommendation that the outside analyses for BOD and TSS be terminated. Furthermore, efforts to achieve certification for the remaining parameters should proceed so that all required analyses are run in-house. To address concerns regarding back-up during periods when Ms. Dorr is away from the WWTP, an

open ended agreement should be established with a contract laboratory to ensure that required analyses are covered during those periods.

### **6.3.2 Process Control Parameters**

The establishment of a small process control laboratory in the old WWTP laboratory building is recommended. This will establish several important advantages for the plant. Due to the increased work load that the above recommendations regarding permit required parameters will place on the laboratory, daily process sampling and testing should be accomplished by the WWTP operators. Not only will this improve the work load distribution but will involve the operations staff more in process testing and decision making. The following discussions provide recommended changes in process control testing.

#### **6.3.2.1 Solids Testing**

The WWTP recently ordered and received a new analytical balance. The old balance should be set up in the operators lab and a small drying oven, dessicator and glassware should be assigned so that MLSS tests can be run daily by operations staff. One volume-proportioned sample of the aeration basins should be analyzed each day for MLSS as discussed during the Phase I Evaluation. Another critical test needed for process control is secondary clarifier effluent and filter effluent TSS. These should be run daily. All settleable solids testing should be run in the proposed operations lab also. Daily analyses of the concentration of the return activated sludge should also be undertaken. The test data should be used to calculate SRT and daily sludge wasting rates.

#### **6.3.2.2 D.O. Testing**

A field D.O. meter with a 50 foot cable/probe should be procured for the operations lab to run D.O. on the aeration basins. Currently, samples are collected and transported to the laboratory. This is inefficient and incorrect in so far as excess aeration can occur in the samples during pouring and transport; also, D.O. depletion is taking place in these samples during transport. The operators should be testing for D.O. in each basin on each shift.

#### **6.3.2.3 Sludge Blanket Depth**

During the Phase I on site evaluation, the ES team recommended that the WWTP procure a sludge blanket finder commonly known as a sludge judge. It is our

understanding that the plant has received the sludge judge. We further recommend that sludge blanket measurements be made on each shift in each of the three clarifiers.

## **SECTION 7**

### **RECORD KEEPING**

#### **7.1 EVALUATION OF PLANT RECORDS (1.4.1.3)**

During the Phase I visit, the ES team evaluated the following records:

- Water Pollution Control Plant Operating Logs
- Discharge Monitoring Reports
- Plant Standard Operating Procedures
- NPDES and Land Application Permits
- Equipment Manufacturers Manuals
- Maintenance Equipment Data
- Maintenance History of Repairs
- Equipment Preventive Maintenance Schedules
- Plant Log Book
- Laboratory Sampling Records
- Laboratory Procedures, Bench Sheets, and Calibration Records
- Safety Records
- Personnel Training Records
- Plant As-built Drawings

In examining the Water Pollution Control Plant Operating Logs and Discharge Monitoring Reports Logs for the twelve months prior to the evaluation, some logs were not readily available and the maintenance of these records was somewhat disorganized. Eventually all the logs were found. This points out the need for improved organization in record keeping with regard to plant operating and discharge data. This was also the case with the Land Application Permit. Copies of all the latest permit related documents should be kept at the WWTP.

The equipment manufacturer's manuals are kept at the plant in file drawers in the superintendent's office. Information was readily available during the evaluation. The system of vendor's literature was available for easy and quick access.

A set of vendors literature for the new plant equipment was taken by the ES team to develop PM schedules for the O&M manual. These will be returned at the conclusion of Phase II of the project.

Equipment data, maintenance history and preventive maintenance schedules are maintained in the base computerized maintenance management system. The system, known as the Recurring Work Program (RWP), generates a weekly report called Recurring Work Program Report (RWPR) which is a listing of equipment items requiring maintenance that week. Each item has an equipment number. The RWPR draws from the master preventive maintenance schedule for items requiring maintenance on a particular week. The RWPR gives a description of the required work, the estimated hours to complete the task and spaces for information once the work is completed which are used to update the maintenance database.

Another important aspect of the maintenance record keeping is the Maintenance Action Sheets (MAS). When a RWPR is generated for an equipment item, the operator or maintenance mechanic can refer to the MAS for that item and receive a detailed listing of required work tasks to be completed and the hours and crew size required to complete the task. Refer to Section 5 of this report which provides a more complete discussion of the WWTP maintenance system and record keeping. Overall, maintenance records were very complete and all essential elements were present.

The WWTP currently maintains a chronological logbook for daily activities at the plant. It has been ES's experience that this is not the best way to keep daily records. We favor use of plant daily operating logs organized by unit process or daily checklists. These systems make it easier to trace the origin of plant and equipment problems. One of the systems should be adopted.

The laboratory records examined were excellent. Complete bench sheet data required for each analyses was being maintained.

A record is maintained of all meter and balance calibrations, temperature logs are maintained for all ovens, incubators and refrigerators associated with lab analyses. A complete set of procedures is in place for the analyses currently being performed.

The only recommended changes in lab records are to include the reference to the analytical procedure on the bench data sheet.

The WWTP had a relatively complete set of as-built plans which are maintained at the control building office.

Safety program record keeping at Shaw AFB WWTP consists of normal AF records. An Employee Safety and Health Record is maintained for each employee on AF Form 55. AF Form 55 keeps information on employee health, accidents and safety training received. In addition, safety briefing records are maintained at the WWTP. Safety inspections conducted by the CE Squadron are documented. One additional record that should be included at the WWTP is a weekly safety inspection checklist. A more detailed discussion of the WWTP safety program is provided in Section 8 of this report.

## **SECTION 8**

## **SAFETY**

### **8.1 PLANT SAFETY PROGRAM**

The WWTP safety program has a number of provisions for promoting a safe work environment and to prevent accidents. Many of the provisions are part of or an extension of the Air Force's safety program. These provisions include training, procedures and equipment.

Training includes first aid for all civilian employees and both first aid and CPR for military personnel. All new personnel receive hazard communication training (HAZCOM). Weekly safety briefings are performed by the Utilities System Supervisor at the WWTP. Lockout/Tagout program training is required of employees before they're allowed to work on electrical equipment. Most records of safety training are kept on-base in individual AF Form 55. The plant maintains a record for safety briefing topics covered at the plant. The Fire Protection Branch provides initial and periodic training to plant personnel on the use and maintenance of the plant's self contained breathing apparatus located at the WWTP. Records of this training are kept in personnel files.

Safety procedures are based on the AFOSH Safety Standards. A work place hazard analysis of the WWTP and related job tasks has been performed. From this, specific safety procedures have been developed. Procedures for safe handling of chlorine gas cylinders, working around open tanks, chemical handling, working around operating mechanical and electrical equipment are included in the job hazard analysis. A listing of personal protective equipment for Environmental Support employees has also been developed. Each employee has safety items or has access to items such as goggles, gloves, hearing protection, fire extinguishers, eyewash, safety showers and self contained breathing apparatus. A procedure and documentation for inspection of all respirators is needed. A weekly safety checklist is needed for the WWTP, lift stations and swimming pool areas. Also, emergency procedures are provided for fire reporting, mishap notification and injury reporting. A procedure is provided to identify and report hazards using AF Form 457, Hazard Report. Detailed operation and maintenance procedures are needed for the self contained breathing apparatus (SCBA) including cleaning,

disinfection and storage. A procedure should be developed for an emergency chlorine leak procedure which includes reporting and evacuation.

Safety equipment located at the plant includes self contained breathing apparatus mounted on the sulfur dioxide feed building. An additional SCBA unit is housed in the old lab. Fire extinguishers are located in the following buildings:

- New Laboratory (4)
- Old Laboratory Building (1)
- Building 300 (1)
- Chlorine Feed Room (1)
- Generator Building (1)
- RAS/WAS Pump Station (1)

Life rings are located at the equalization basin, aeration basins, backwash water tank, clarifiers (1), digestors (2) and chlorine contact chambers. A safety shower and an eyewash unit are located in the lab and an eyewash unit is located at the old lab building.

The plant has a combustible gas/oxygen meter available for safe entry into vaults, wet wells or areas where oxygen could be deficient. This meter is kept on the maintenance truck used for making rounds to the lift stations, etc. (1.4.1.7)

## 8.2 ADDITIONAL SAFETY NEEDS

Overall, the WWTP safety program was found to be comprehensive and well documented. The following items came to the attention of the ES evaluation team that need to be addressed:

- Additional fire extinguishers should be procured for the new Motor Control Center Building, the current wooden structure utilized as an operation building and the Filter Control Building.
- An additional safety shower should be installed at the old lab/chlorine building. The unit should be mounted away from the door into the chlorine feed room so in the event of personnel contamination with chlorine, flushing of skin can be accomplished safely.
- Additional life rings are needed at the clarifiers (2) and digestors (1).

- An emergency procedure is needed for responding to chlorine leaks, for reporting leaks and evacuation of personnel during chlorine leaks.
- A safety equipment checklist is needed for weekly inspection of all plant safety equipment.
- Procedures should be developed for operation and maintenance of the SCBA units including cleaning, disinfection and storage.

## SECTION 9

### CONCLUSIONS AND RECOMMENDATIONS

#### **9.1 CONCLUSIONS**

The following conclusions have been reached as a result of the Phase I visit, document reviews and continued communication with WWTP personnel.

1. Although the plant has a number of excellent programs in place and is generally well operated, the treatment performance during the twelve months prior to the Phase I evaluation was marginal. A total of 31 instances of noncompliance with the NPDES permit limitations occurred during this period. New plant equipment and processes installed during the plant upgrade should help to improve the future plant performance.
2. There are a number of areas where improved process operation and/or monitoring should be implemented. These areas include activated sludge process control, waste activated sludge pumping, secondary clarifier operations, and aerobic digester operations.
3. Laboratory operation and recordkeeping were excellent and self monitoring data is generated in accordance with approved procedures and protocols. Laboratory certification should be obtained for all permit required parameters and duplication of resources through use of an outside lab should be eliminated as soon as possible.
4. The WWTP maintenance program which utilizes the computerized, base-wide Recurring Work Program is very comprehensive. Through observation of the documentation for this program, it appears that the maintenance program is fully implemented and contains all the essential elements.
5. Increased efforts in the area of wastewater training are needed especially for the military operators who, for the most part, lack technical training in this area. Correspondence courses, in-house training and outside seminars should be utilized.
6. Staff size does not appear to be a problem relative to the size and complexity of the WWTP. However, utilization of personnel should be optimized. This will require upgrading water treatment equipment and installation of monitoring equipment for the lift stations.
7. Management structure and practices for the WWTP are adequate. Improved communication regarding WWTP operations, strategies, and problems through regular staff meetings will enhance management effectiveness.

8. The issue of whether toxic wastewater may be having a deleterious effect on WWTP operations requires further data for evaluation. A comprehensive survey of all base maintenance shops and their waste handling practices is needed.
9. Plant recordkeeping needs improvement in overall organization. The WWTP should initiate use of an operational log or daily plant checklists.
10. The plant safety program for the most part is excellent. A few small improvements are needed with regard to equipment records and procedures.
11. Sources of excessive plant flow should be further investigated including an I/I analysis if needed. Plant flow monitoring equipment calibration needs to be checked and serviced regularly.

## **9.2 RECOMMENDATIONS**

Table 9.1 presents recommendations for optimizing operation, maintenance and process control at the WWTP. Broad cost estimates for implementing the recommendations are also included where possible.

**Table 9.1. Shaw AFB Wastewater Treatment Plant Specific Recommendations and Estimated Implementation Costs**

Recommendation	Comments/Significance	Estimated Cost of Implementation
1. A map of the sludge land application system should be developed including numbered plots which can be used to facilitate records of disposal.	To optimize even distribution of sludge and loading on the site.	None.
2. Improved records of sludge disposal should be kept.	Data on disposed sludge, site loading, and disposal locations should be maintained.	None.
3. The WWTP should improve daily operations records by developing forms for recordkeeping by plant personnel.	An operational log or daily check sheets should be used.	None.
4. Improvements should be initiated in personnel utilization.	Decrease field time through equipment upgrading at water booster stations and monitoring of lift stations.	Capital cost items. No estimate available at present.
5. The WWTP should develop a weekly safety equipment checklist.	Including all plant safety equipment.	None.
6. Implement technical training for military operators in wastewater treatment operations.	Use correspondence courses such as "Operation of Wastewater Treatment Plants" from Sacramento State University and in-house training.	Approximately \$100 per operator for the correspondence course.
7. Send senior O&M personnel to outside seminars once per year.	Two persons per year.	\$500-1000 per year depending on the location.
8. Develop a reference/training library at the WWTP.	Books can be obtained through the base library. Refer to list in Section 3 of this report.	\$250-300.
9. Hold weekly staff meetings at the WWTP.	To inform operators of operational strategies and trends and discuss problems/solutions.	None.

**Table 9.1 (Continued). Shaw AFB Wastewater Treatment Plant Specific Recommendations and Estimated Implementation Costs**

Recommendation	Comments/Significance		Estimated Cost of Implementation
10. Initiate troubleshooting procedures at the grit removal system.	Determine reasons for lack of grit removal.	None.	
11. Provide vendor training for the operation of the influent screw pumps variable speed drives.	Variable speed drive operation should be incorporated into the EQ basin operating strategy.	No cost to WWTP.	
12. Install a viable lime feed system at the plant headworks to increase alkalinity for proper functioning of the activated sludge system.	System must be capable of feeding 275-300 pounds per day of lime.	Up to \$5,000 depending on availability of equipment, tankage piping, etc. in-house.	
13. Implement a process control strategy for the activated sludge system based on maintaining a constant SRT.	Initial target SRT should be 22 days.	None.	
14. Waste sludge from the activated sludge system daily.	Based on wasting calculations provided during Phase I.	None.	
15. Obtain a D.O. meter with a 50-foot cable/probe for measurement of D.O. in the aeration basins.	Each basin's D.O. should be measured daily.	\$1500 for meter and probe.	
16. Purchase a "sludge judge" for measuring sludge blanket depth in the secondary clarifiers.	Each clarifier should be monitored for blanket depth once/shift.	Less than \$100.00.	
17. Purchase and install a flow meter for the WAS line.	WAS flow is a critical process control measurement.	Approximately \$5,000.	
18. Replace all media in the tertiary filters.	Anthracite, sand and gravel.	Approximately \$1,000.	
19. Repair or replace the out-of-service surface washing equipment on the tertiary filters.	Backwashing improvements.	Up to \$500.	

**Table 9.1 (Continued). Shaw AFB Wastewater Treatment Plant Specific Recommendations and Estimated Implementation Costs**

Recommendation	Comments/Significance	Estimated Cost of Implementation
20. Develop an operating strategy and maintain records of filter operation as outlined in Section 4.1.6.	Improve long term filter operation and backwashing effectiveness.	None.
21. Modify piping at the chlorine contact chambers to allow use of the new chamber during normal operations.	Unit can presently be used only during filter bypass.	Piping and construction costs are unknown at present.
22. Implement aerobic digester operating strategy as outlined in Section 4.1.8.	Control the process based on percent reduction in volatile matter.	None.
23. Increase maintenance priority on tank truck used to haul liquid sludge to land application site. Use contract hauling during extensive periods of truck down-time.	Maintain sludge removal capability to the greatest extent possible to ensure plant process operations are not adversely impacted.	None.
24. Conduct an industrial survey of all base maintenance shops and their waste hauling practices.	Identify all potential sources of problems to WWTP operations.	None. Unless survey is contracted out.
25. Perform a detailed follow-up inspection and analysis of records at the base Photo Shop to verify past disposal of penetrant line baths.	This shop has a strong potential impact on the WWTP.	None.
26. Replace or repair the skimmers on the secondary clarifiers.	A work order was written for this during the Phase I visit.	None.
27. The weirs on the secondary clarifier should be checked to ensure that they are level.	Requires a transit and may require assistance from CE squadron.	None.
28. Improve housekeeping in and repair doors on the digester blower room.	Closing doors will improve housekeeping in this area greatly.	\$200.
29. Document changes made to filter instrumentation and controls.	Circuit diagrams are needed.	In-house cost.

**Table 9.1 (Continued). Shaw AFB Wastewater Treatment Plant Specific Recommendations and Estimated Implementation Costs**

Recommendation	Comments/Significance	Estimated Cost of Implementation
30. Implement minor procedural and BOD, TSS.	None.	
recordkeeping changes for laboratory analyses discussed in Section 6.2.		
31. Obtain laboratory certifications for all permitted parameters and use in-house analyses for reporting to DHEC.	Discontinue outside contract lab for certified parameters.	Initial cost approximately \$5,000/year
32. Run solids tests on MLSS, RAS, WAS, secondary clarifier and filter effluent daily.	Necessary process control testing for plant operation.	None.
33. Improve organization of plant records.	WWTP operating logs, DMRs, permits.	None.
34. Develop a weekly safety inspection checklist.	Ensures safety equipment is available and working.	None.
35. Purchase additional safety equipment discussed in Section 8.2.	Fire extinguishers, safety shower, life rings.	Approximately \$1,000.
36. An emergency procedure is needed for responding to chlorine leaks.	Response, reporting, evacuation, etc.	None.
37. Procedures are needed for the WWTP SCBA equipment.	Cleaning, disinfection, storage.	None.